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INCIDENCE OF AND RISK FACTORS FOR INJURY AND ILLNESS AMONG MALE AND FEMALE ARMY BASIC TRAINEES

U S ARMY RESEARCH INSTITUTE
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To establish the incidence of and risk factors for training injuries and illness, 310 U.S. Army Trainees (124 men and 186 women) were followed prospectively through one basic combat training (BCT) cycle of eight weeks duration. During BCT 51% of females and 27% of males were injured. Females suffered 481 days of limited duty secondary to injury while males incurred 99 days of limited duty.

For females slow mile time, low number of push ups and sit ups, high and low body mass index, and short and tall stature were associated with increased risk and injury during BCT. For males slow mile time, high body mass index and low levels of previous physical activity were associated with increased risk for injury. When risk of injury for females versus males was adjusted for physical fitness level there was no difference in risks between them.

In regard to illness, 48% of females and 35% of males reported on sick call for an illness .

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Major conclusions drawn from this study of a population of male and female trainees were that injury was the major cause of morbidity and that higher risks for injury and to some extent illness were associated with low levels of initial fitness and low levels of prior physical activity.

HUMAN RESEARCH

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

The views, opinion, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

TECHNICAL REPORT

T 19/88

Incidence of and Risk Factors for Injury and Illness Among Male and Female Army Basic Trainees

by

Bruce H. Jones, MAJ, MC; SGT Ronald Manikowski;

John H. Harris, M.D; Joseph Dziados, MAJ, MC;

Scott Norton, CPT, MC; Tom Ewart, LTC,MC;

James A. Vogel, Ph.D.

United States Army Reseasrch Institute

of Environmental Medicine

Natick, MA 01760-5007

June 1988

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ABSTRACT

To establish the incidence of and risk factors for training injuries and illness, 310 U.S. Army Trainees (124 men and 186 women) were followed prospectively through one basic combat training (BCT) cycle of eight weeks duration. During BCT 51% of females and 27% of males were injured. Females suffered 481 days of limited duty secondary to injury while males incurred 99 days of limited duty.

For females slow mile time, low number of push ups and sit ups, high and low body mass index, and short and tall stature were associated with increased risk and injury during BCT. For males slow mile time, high body mass index and low levels of previous physical activity were associated with increased risk for injury. When risk of injury for females versus males was adjusted for physical fitness level there was no difference in risks between them.

In regard to illness, 48% of females and 35% of males reported on sick call for an illness of some kind. However, if risks of illness were compared excluding gynecological complaints, the risks were 37% for females and 35% for males. Also 26% of females and 28% of males required medical care for an upper respiratory tract infection (URI). The total number of days of limited duty due to illness for females was 23 and for males 19, mostly secondary to upper respiratory tract infection. For females low level of prior physical activity was associated with increased risk of having an upper respiratory tract infection, while for males both slow mile times and low levels of prior activity were associated with risk of an upper respiratory tract infection.

Major conclusions drawn from this study of a population of male and female trainees were that injury was the major cause of morbidity and that higher risks for injury and to some extent illness were associated with low levels of initial fitness and low levels of prior physical activity.

INTRODUCTION

Injuries and illnesses are common occurrences in military populations even in peace time (Health of the Army supplement on infectious and parasitic disease and on injury 1981). The incidence of musculoskeletal injuries (Bensel 1983, Kowal 1980, Reinker 1979) and upper respiratory tract infections (Brundage 1988) are especially high during the early phases of Army initial entry training. Data from several authors (Bensel 1976, 1983 and Kowal 1980) suggest that the incidence of musculoskeletal injuries during military Basic Combat Training is of "epidemic" proportions. On the other hand, the incidence of illness, in particular upper respiratory tract infections and meningitis, seems to be fairly well controlled by preventive measures such as vaccines and morbidity is limited by use of antibiotics. Unfortunately, routine data are only maintained for injuries and illnesses resulting in hospitalization, while most of the complaints, especially for injuries, are treated on an out patient basis. Thus the full magnitude of the injury epidemic in particular is not known.

In regard to training injuries, there is a growing suspicion in sports medicine circles that many common athletic, especially running injuries can be prevented by judicious training practices. Because the nature of the training and the injuries incurred during Army training are so similar to those experienced by civilian athletic populations, particularly runners and joggers, it seems reasonable to assume that Army training injuries should also to some extent be preventable (Jones, 1983). Despite the strong suspicions, there is little good evidence identifying specific risk factors or

documenting the efficacy of preventive strategies for training-related injuries. There is even less evidence regarding the associations between physical training, fitness and illness.

The following background discussion will focus on what is known about physical training-related injuries in military and to some extent civilian populations. This will be followed by a brief discussion of the effects of physical training on the likelihood of illness. Subsequently the methods and results of a training injury study of male and female Army trainees conducted at Ft Jackson in 1984 will be described. The incidence of injury and time lost from training for trainees at Ft Jackson will be reported and compared to the morbidity due to illness. Also, risk factors for injury and illness identified by this study will be discussed. Finally, the results of the present study will be discussed in the context of the available military and civilian literature on training-related morbidity from injuries and illness.

BACKGROUND ON TRAINING INJURIES

It is becoming increasingly obvious that physical training-related injuries are a significant, if not epidemic problem for the Army and the other military services - a problem that has to a large extent been overlooked until recently. As a consequence there are few military studies published on this problem and most are not designed well enough to provide reliable incidence data, let alone to identify risk factors for training-related injuries. Also, most of the available literature deals with Basic Training populations, few with trained troops. Extrapolating from Health of the Army reports it can be estimated that three to five thousand hospitalizations occur annually Army

wide as a result of physical training and sports participation - about 7 hospitalizations per 1000 man-years (Health of the Army supplement on injury 1982). These injuries account for about 100,000 hospital man-days a year. Hospital admissions represent only a small portion of the problem, however, since the vast majority of training injuries are treated on an outpatient basis. This is problematic because even those injuries such as stress fractures treated on an outpatient basis can be disabling, causing victims to miss training or duty and in some instance to be discharged from the Army (Bensel 1983, 1976, Kowal 1980).

Among trained soldiers at Ft Lewis, Washington, Tomlison (1987) found there were 80 injuries per 100 troops per year. Fifty five percent of these injuries were the result of exercise or sports related activities. Also, about 50 percent of these injuries resulted in some type of restriction of the soldiers duties.

While the above rates for trained troops may seem high, the incidence for Basic trainees is much higher. Observations from several studies indicate that the cumulative risk of injury over the 8 week basic combat training cycle is about 25 percent for males and 50 percent for females (Bensel 1983, Kowal 1980). Also, parenthetically the relative risks for females to males is consistently about 2 to 1.

Despite the evidence that training-related injuries are a significant problem for the Army little is currently being done to actively prevent them. To a large extent this is because the etiology of most injuries is poorly understood and because of the long held belief that such injuries are in a

sense "the cost of doing business" for the Army and other physically active populations.

The spectrum of injuries seen among Army trainees and soldiers is similar to that observed in civilian runners and joggers (Jones 1983), which suggests that weight-bearing physical training may be the primary risk factor for such injuries. Lower extremity injuries attributable to overuse, like those seen in runners, account for over 50 percent of the injuries to basic trainees in the Army (Jones 1983, Kowal 1980, Reinker 1979). Unfortunately, there are no good military studies on injury prevention and the civilian sports medicine literature is also for the most part anecdotal providing little useful guidance for injury prevention. The preponderance of the current hypotheses concerning the causation and prevention of training and sports injuries is based on case series reports (Koplan 1985, Walter 1985, Powell 1986). These type studies, case series, provide no means of calculating and comparing risks within different populations or subpopulations and therefore do not support conclusions about causality or prevention. Thus, while there is an abundance of clinical data to direct our treatment of training injuries, there is virtually no epidemiologic foundation upon which preventive strategies can be built. The only clearly identified risk factor to date is higher running mileage (Pollock 1982, Koplan 1982, Blair 1987, Marti 1988).

One naive strategy would seem to be to decrease the volume of running and marching mileage. However, the Army and other services are in a double-bind in this regard. Although activities like running and marching appear to be the most significant risk factors for overuse type training-related injuries, they are also the most economical and efficient means of developing aerobic

fitness. Endurance is an essential component of the type of fitness demanded for military-preparedness (FM 21-20), because marching is frequently the only practical way to move large number of troops from one loaction to another over fairly extended distances sometimes with loads of 50 to 100 pounds.

Furthermore, increased endurance and transportation are not the only beneficial results of aerobic weight-bearing activity. There is growing evidence that routine physical activity is a protective factor against cardiovascular disease [MMWR 36(26): 426-430, 1987, Paffenbarger 1984, Paffenbarger 1987, Paffenbarger 1978] and other causes of morbidity and mortality (Paffenbarger 1987, Siscovick 1985). The evidence supporting the health benefits of routine exercise and activity is strong enough that the U.S. Public Health Service has made increased physical fitness of the American public one of its 15 objectives for 1990 (Promoting Health/Preventing disease: Objectives for the Nation, US DHHS 1980, Healthy People, SGs Report, US DHEW (PHS) 1979). For similar reasons the Army and other services have recognized a need for and have placed increased emphasis on the development and maintenance of physical fitness. Exercise which includes weight-bearing aerobic activities is encouraged to maintain and prolong the health of service members. Members of the Armed Services of all ages are now required to demonstrate adequate fitness levels on a standard physical training test (2 mile run, push ups and sit ups) twice a year.

Because of the compelling logistic and health reasons for the Army to maintain the fitness of soldiers through marching, running and similar activities, it is unlikely that any aspect of physical training will be abandoned simply to reduce the number of injuries especially if fitness will

be adversely affected. Therefore it will be especially important to identify risk factors for injury that can be modified to reduce injury rates while maintaining the same or nearly the same levels of fitness as currently observed in troops.

Potential risk factors for training-related injury can be divided into two crude categories - intrinsic and extrinsic factors (Jones 1987). Intrinsic risk factors are inherent characteristics of the individual such as gender, age, body composition, fitness level and so forth. Extrinsic risk factors are variables outside of the individual such as environmental conditions, terrain features, equipment (shoes, boots, insoles and the like), and training parameters (intensity, duration and frequency of an activity).

Risk factors cited in the literature which clearly need further study include:

1. Gender (Blair 1987, Koplan 1985, Bensel 1983, Kowal 1980, Reinker 1979)
2. Age (Powell 1986, Koplan 1985)
3. Body composition (Koplan 1985, Kowal 1980, Bensel 1976)
4. Anatomic factors (Clement 1981, James 1978, Bensel 1976)
5. Level of physical fitness (Koplan 1985, Kowal 1980)
6. Prior health (Koplan 1985)
7. Equipment (Jones 1983, Gardner in press)
8. Training program parameters such as intensity, duration, and frequency of activity (Blair 1987, Powell 1986, Koplan 1985, 1982, James 1976)

Although not all of the listed risk factors are modifiable, most of them should nevertheless be studied simultaneously. It is necessary to gather information on unmodifiable factors such as sex, age and anatomy to determine

their impact on risk and to control for any confounding effect they may have on other potential risk factors even when the primary interest is to identify or determine the effect of modifiable risk factors.

BACKGROUND ON ILLNESSES

Regarding the impact of illness on the health of the Army, it has been well documented that during all major military conflicts involving the United States from the Civil War through the Vietnam conflict the major cause of serious non-fatal morbidity (hospitalization) has been disease (Reister, FA 1975, and Health of the Army Supplements 1969-1970), primarily infectious disease. However, in the peacetime Army of today accidents and injuries (Health of the Army Supplement on Injury 1982) appear to be the most common cause of hospitalization and time lost from duty. The available statistics only examine conditions which are hospitalized, so the relative proportion of outpatient morbidity attributable to infections and other disease versus injury is not documented.

Furthermore, the relationship between vigorous training activities and illness in military populations have not been documented. Although there is a presumption that rigorous physical training or overtraining may have a deleterious effect on health this has not been demonstrated one way or the other for military or civilian populations (Simon 1987, 1984). While, the short term effect of physical fitness on likelihood of infectious or other disease has not been well documented, there is some data on the reverse effect of infectious disease on physical performance where it has been documented that physical performance deteriorates during illness (Daniels 1985, Friman 1985, Roberts 1986).

A study of Army trainees conducted at Fort Jackson in 1984 will be described next. This study examined primarily intrinsic risk factors for illness and injury, and attempted to establish the relative amounts of morbidity expectable secondary to injury and illness among Army trainees.

PURPOSE OF THE STUDY

In a recent review of injuries in sports and recreation Kraus and Conroy (1984) stated:

"From a public health prospective, well designed epidemiological studies dentifying populations at risk and factors associated with injury causation are fundamental to the development of preventive strategies".

They also argue that to fully address the public health concerns regarding injuries, data is needed not only on specific injuries, but also on the medical costs, time lost from work, disability, and other less apparent social costs.

It was the objective of this study to address some of the concerns raised by Krans and Conroy (1985) in the context of Army Basic Combat Training. The specific objectives of this study were as follows:

1. To document the incidence of training-related injuries among male and female trainees. Also, to account for the amount of disability and time lost from duty due to injury.

2. To determine the impact of entry level physical fitness and related factors on the risks of injury in males and females.

3. To establish the relative risks of injury for males and females.

4. To document the incidence of illness among trainees and to contrast the incidence of illness and associated disability with that of injury.

Our primary hypothesis was that low levels of entry level fitness predispose individuals to a greater risk of injury and to a lesser extent illness. Furthermore, it was our suspicion that to a large extent the observed differences in incidence of injury between males and females is due to the lower levels of fitness among women entering the Army.

SUBJECTS

Three hundred ten Army trainees (124 males, 186 females) were followed prospectively through the entire eight weeks of Army Basic Combat training. Descriptive characteristics and physical fitness of males and females can be seen in table 1. The median age for males was 19 years and for females 20 years. Sixty five percent of males were white, 21 percent black, and 14 percent other racial groups. Fifty four percent of females were white, 35 percent black, and 11 percent other racial groups. In regard to past physical activity and sports participation, 12.1 percent of males and 28.5 percent of females had been sedentary, participating in no sports or active recreation prior to military service. At the other end of the activity spectrum, 54.8 percent of males had participated in varsity sports in high school or college, while only 40.8 percent of females had participated at a similar level. Thus a significant portion of the population observed was fairly active before entry to the Army, however, a sizeable portion of both genders professed sedentary lifestyles.

Prospective subjects were all male and female trainees at the Fort Jackson Reception Station who had been through their initial entry processing and were ready to join training units. These trainees arrive in a semi-random fashion from locations around the United States and are first processed and then held at the reception stations until enough individuals arrive to fill a company size unit (150-200 trainees). Males and females were placed in separate units based on gender.

METHODS

This study was conducted between 14 January and 14 March 1984 at Fort Jackson, SC. Initially 391 individuals were available and all volunteered and were screened for the study after being informed of its nature. All of the males screened (n=156) were placed in one company, however, 56% of the original population of females (n=235) were placed in one female company and the remaining 44% filled another. All three hundred and ninety one males and females were measured for height, weight, and percent body fat. These same 391 volunteers were given a questionnaire on past physical activity and sports participation. However, 21.3 percent of those initially measured (22.0% of males and 20.9% females) were lost to follow-up prior to the time their medical records were screened in the last week of training. Individuals were lost to follow-up as a result of early discharge from the Army, transfer to another unit or failure to begin training in the first place (see appendix 1 for a description of those lost to follow-up). Thus the study population analyzed for the occurrence of injury and illness was 310 trainees as stated above.

Data collected on subjects included objective measurements consisting of anthropometric measurements of height, weight and percent body fat, and physical fitness data collected by means of an initial and final physical fitness test (a timed run, pushups, and situps). Subjective measures of fitness and activity were also obtained by means of a questionnaire.

Each of the anthropometric and fitness measurements and the activity questionnaire will be described in detail in the following sections.

1. Objective measures

a. Anthropometric measures: Height was measured in centimeters (to nearest 0.5cm) with an anthropometer, while weight was measured in kilograms (to nearest .1kg) on a scale that was calibrated daily. For the height and weight measures male and female subjects were barefooted and dressed in T-shirts and shorts. Body mass index (Quetelet index) was calculated from height and weight measures by the formula - weight (kg)/ height^2 (m) X height (m)(Revicki DA, AJPH 1986). Percent body fat was also estimated by measuring skinfolds at four sites (biceps, triceps, subscapular, and suprailiac) with a caliper according to the techniques of Durin and Womersley (1974). These four sites were each measured three separate times and the averages for each site were then added together and the sum was used to determine the age and sex adjusted percent body fat (Durnin 1974).

b. Physical fitness test measures: Army physical training test scores were used as an objective measure of pre and post-training physical fitness of both male and female trainees Initial entry fitness was assessed in the first 7 to 10 days by a "Diagnostic Physical Training Test". This test consisted of a one mile run for time, as many push-ups as an individual could do in two

minutes and as many sit-ups as possible in two minutes. The mile was run on a track and each individual's laps were counted and their finishing time recorded by official observers, usually Drill Instructors. Likewise, time for doing push-ups and sit-ups was officially monitored and the number of push-ups and sit-ups performed by each trainee were counted and observed for correct form by an official observer. The final physical fitness test, the "Army Physical Readiness Test" (APRT) as it was then called, was performed in the last week of training. The final test was conducted in the same manner as the initial test except that instead of a one mile run, each trainee was required to run two miles for time. The time for doing push-ups and sit-ups was two minutes as with the earlier test. These Army physical fitness tests were conducted in a uniform manner for both males and females as specified in the Army Field Manual (FM) 21-20, 1980.

Some trainees did not take the initial and final physical training (PT) tests. Reasons for not taking the test were assignment to details such as kitchen patrol, or medical restrictions of duty for prior injury or illness. Seventy nine males (64%) took the entire initial PT test and 98 (79%) took some portion of the test. One hundred forty females (75%) took the entire initial test and 163 (88%) took at least part of the test. One hundred and one (81%) males and 152 (82%) females completed the final PT test. When results of these PT tests or statistics based on them are reported in tables or text the numbers (n) involved will be reported.

2) Subjective measures (questionnaire)

The activity questionnaire was administered to trainees in two groups on two separate occasions. The questionnaire was delivered in the same manner each time by the same monitors. Detailed standardized directions were given for each question and each question was read out loud to the entire group by one of the monitors. Activity and sports participation was assessed by the following approach.

a. Current activity: Volunteers were asked to circle the activities on a list of activities which they did on a regular basis in the last 6 months. Regular activity was defined as 2 or more times per week at least 3 weeks per month. The list included activities such as running, walking, weight lifting, baseball, soccer etc. or other (for a complete list see questionnaire in appendix 2).

b. Past activity: Individuals were asked to list physical activities that they had done in the past, how many years they had done the listed activity, and to list what year was the last one they had done it.

c. Never active: Individuals were determined to have never been active, if they did not circle or list any current activities and if they listed no past physical activities.

d. Years of exercise: The years of regular exercise were determined by adding up the number of years of past activities listed.

e. Athletic status: Subjects were asked if they participated in high school or college sports. If they answered "YES" they were asked at what

level - varsity competition in high school or college, other organized school or club sports (e.g. intramurals or YMCA), or non-routinely organized games and activities with friends (e.g. pick-up games etc.).

f. Self-assessed activity level: Individuals were asked how they would describe their lives in terms of activity level prior to entering the Army -- not very active, average, active, or very active. A question similar to this one was validated by Washburn et al (1987).

3. Physical Training Program:

While actual amounts of daily physical training were not documented, in general training for all males as a group was the same, and likewise for females. This is true because virtually all conditioning of trainees was done at the unit level according to a standardized program of instruction. Furthermore, there is little time for individual fitness or sports activity during basic training. However, because the males and females trained in separate units the training between genders, though similar, was not identical with the training of women being less rigorous than for men.

In general physical training was conducted on a daily basis five or six days per week usually in the morning. The normal training day began between 5 and 6 AM with calisthenics and stretching followed by a run. Calisthenics usually took 30 minutes to one hour, while the daily run distances were increased progressively over the duration of the 8 week training period. Runs progressed from 1/2 to 1 mile per day in the first 2 weeks to 2 to 3 miles per day by the last week and as much as 5 miles on occasion. Weekly run mileage for a unit generally increased from 3 or 4 miles for the first week to

10 to 15 miles per week by the end of the training cycle. While not a part of the physical training program per se, additional training effects and stress to the musculoskeletal system resulted from weight-bearing activities like marching and drill and ceremony. Drill and ceremony might entail marching in formation and close order drills for one or two hours per day. Also, on any given day there would usually be at least one or two miles of marching to and from training sites. Additionally, the program of instruction for basic training for males and females required two longer road marches with full combat gear. These marches were specified to be of at least 6 to 8 miles in length for the first march and 8 to 10 miles for the second. Thus it was possible for troops to perform of 30 or 40 miles per week of weight-bearing training, i.e. running and marching. Other physiologic and musculoskeletal stressors included such activities as obstacle courses, confidence courses, hand to hand combat training, and rifle-bayonette training.

4. Medical data

Medical data was gathered by means of a 100 % record review of every volunteer whether or not they were injured. On entry to the service a medical record is established for every trainee. If nothing else this record contains their entry physical exam and shot records. Trainees are required to check this record out and take it with them for every sick call visit. Also, health care providers are required to place a clinical note in the record of each trainee examined. These records were screened and information was transcribed to data forms for all trainees with one or more sick calls visits (clinic visits for medical treatment).

For injuries the medical data transcribed was the date of the injury, the diagnosis (e.g. stress fracture, ankle sprain, contusion etc.), the location of the injury (i.e. right arm, left ankle etc.), the disposition (i.e. return to duty, light duty, no duty, hospital etc.), and the number of days of medical restriction of duty if any.

For illnesses the data transcribed was the date of the visit, the diagnosis (i.e. cold, flu, gastritis, urinary tract infection etc.), the system involved (i.e. upper respiratory tract, lower gastro-intestinal tract, urinary tract etc.), the disposition, and the number of days of medically restricted duty.

a. Operational definitions of injury:

Because of the small sample size this operational definition of injury was employed for most analyses, especially for contrasting levels of risk factors for injury among males and females. The most common definition of injury applied was any sick call visit for a complaint of musculoskeletal pain, disability or trauma.

A more restrictive operational definitions employed in some analyses was a musculoskeletal complaint for which a day or more of medically restricted duty was prescribed.

Some other more specific definitions were employed such as stress fractures and these will be identified in the appropriate locations in the text and/or tables.

b. Operational definition of illness:

The primary operational definition of illness used was simply any sick call visit for a medical complaint other than an injury, usually conditions such as colds, influenza, diarrhea, rashes etc.

As with injury a more restrictive definition of illness was employed in some instances and stipulated consideration of only illnesses for which a day or more of medically restricted duty was prescribed. Medical restrictions for illnesses were most commonly due to upper respiratory tract infections (URI) which were accompanied by a fever of 100 degrees F or more. These restrictions usually entailed hospitalization on the URI ward.

Because of their prevalence analyses were carried on to specifically identify risk factors for upper respiratory tract infections. An upper respiratory tract infection was defined as an illness with symptoms such as "sore throat" and "runny nose", accompanied "headache", "muscle aches", or fatigue with or without documented fever.

5. Analytical methods

Data was analyzed using BMDP statistical packages to perform t-tests, cross tabulations and Mantel-Haenszel (MH) Chi-squares (BMDP statistical manual, 1985). Comparisons of means for male and female anthropometric and fitness measures were performed using t-tests. Contrasts of incidence of injury and illness between males and females were first analyzed using simple chi-squares and were later stratified and analyzed by fitness levels using MH

chi-squares. Categorical activity and fitness data were analyzed by comparing the risks of subjectively assessed high risk groups against low, or baseline reference groups. For continuous variables such as mile run time and BMI males and females were divided into quartiles from low to high values or vice versa. The risks of each level of fitness was then contrasted with what was assessed to be the baseline or low risk group for each variable. For all contrasts of risks the risk ratios (RR) (risk in group of interest/ risk of baseline reference group or level) were calculated and either 90 or 95 percent confidence intervals (CI) were drawn using the methods described by Rothman (1986). Risks between contrasted levels were considered to be significantly different if the 95% CIs of the risk ratios did not encompass one (the null value for RRs). If only the 90% CI did not encompass 1, the results were considered to be marginally significant, highly suggestive and worthy of further investigation. Finally, a stepwise logistic regression model was developed using BMDP software.

In the analysis, the two female units were treated as one group since the injury rates were the same (52% versus 49%, Chi sq=.23,p=.9) as were their average anthropometric and fitness scores (see Appendix 8).

RESULTS

1. Incidence of injury

It is apparent from the data collected that the incidence of sick call visits for musculoskeletal complaints is quite high during Army basic training. The cumulative incidence (risk) for females, 50.5%, was almost twice the 27.4% observed for males, a significant difference in risks (RR=1.84,p < .05, see table 2).

The incidence of injury as defined by other operational definitions for injury occurrence, also demonstrated a greater cumulative incidence of injury among women. Confining the definitions to lower extremity injuries only, the cumulative incidence for women was 44.6% versus 20.9% for men, a significant difference [RR=2.13, 95% confidence interval (CI) 1.46-3.10) $p < .05$, see table 2]. For clinically diagnosed stress fractures and stress reactions of bone the incidence for women and men were 11.3% and 2.4%, respectively (RR-4.6, $p < .05$, see table 2). The incidence of injury using a more conservative definition of injury, i.e. one requiring a day or more of medically restricted duty, we can see that the incidence for females is also higher than for males, 30.2% versus 20.2%, a difference marginally significant at the .05 level (see table 2). It is also, worthy of note that the rates of days lost are about three times as high for women as men. Women lost 32.2 days per 100 person-weeks compared to 10.0 days per 100 person-weeks for men.

The majority of injuries were lower extremity musculoskeletal complaints. For males 88% of all injuries were lower extremity conditions and for females 92%. The most commonly reported musculoskeletal complaints are listed in table 3. For males the most frequent types of injury seen as a percent of the total injuries seen were musculoskeletal pain (attributed to overuse)(32.7% of complaints), low back pain (16.4%), tendonitis (14.5%), and sprains (10.9%). For females the most common complaints were musculoskeletal pain (37.4%), stress fractures (19.7%), muscle strains (16.3%), and sprains (7.5%). Thus the distribution of injuries for men and women by type of complaint was somewhat different.

If we examine the distribution of injuries over time for males and females, it is apparent that the incidence curves for both are similar in form (see figure 1). As can be seen in figure 1, the rate of first sick call visits rises fairly steadily for both genders through the fourth week after which it declines sharply into fifth week rising sharply again for women in the sixth week and in the seventh for men. The decline in injury rates for males and females in the fifth week coincided with a week of bivouac, camping out in the field, a time when they did little or no running or calisthenics. It is also apparent from the epidemic curves that the rate of injury is higher for women at virtually all points in time. The average weekly rate for women was 9.9 new musculoskeletal complaints per 100 women per week, while the rate for men was only 5.5 new complaints per 100 per week.

2. Risk factors for musculoskeletal injury

The risks (cumulative incidence) of injury for men and women assessed by objectively measured levels of fitness such as mile run times, number of push-ups, percent body fat etc., demonstrated some fairly consistent patterns of risk for both genders (see table 4a for women and table 4b for men). Perhaps the most consistent and significant pattern of risk is for endurance fitness as measured by mile run time. For both men and women the risk of injury is slightly higher for the fastest quartile of trainees and then after the lowest incidence in the second quartile the risks rise steadily in value and significance for the next two quartiles (see tables 4a and 4b). Comparing the risks of injury for the slowest two quartiles of men to the fastest two, the risks are 34% versus 12% with a risk ratio (RR) of 2.81, significant at $p <$

.05, (95% (CI), 1.1 to 7.1). For women, the risks for the slow versus fast groups with one or more injury are 59% versus 35% with a risk ratio of 1.69, significant at P=.004, (95% CI, 1.17 to 2.46). Focusing on just lower extremity musculoskeletal complaints, the risks of slow males compared to fast ones is 29% to 10%, risk ratio 2.97 (p = .03, 95% CI, 1.03 to 8.53, see table 7). Comparing lower extremity injury risks in slow versus fast women, the contrast is 54% to 31%, a risk ratio of 1.78 (p = .004, 95% CI, 1.2 to 2.7, see table 7A). Comparisons of risk for other specific definitions of injury, such as stress fractures, exhibit similar trends of increased risk for the slower trainees, but fail to reach levels of statistical significance because of small numbers of these specific injuries.

From an administrative stand point, perhaps the most meaningful definition of injury is time lost from duty or training due to medical restriction. For males 28.9% of the slow mile run group suffered a time loss injury, while none of the faster ones did (p = .003 using Fisher's exact test, see table 6b). Among females 38% of the slower trainees sustained a time loss injury compared to 18% of the faster ones with a risk ratio of 2.1 (p = .008, 95% CI, 1.2 to 3.6, see table 6a). It appears that among both males and females those trainees with lower levels of endurance on entry to the Army are at greater risk of sustaining a musculoskeletal injury as defined by a variety of criteria.

Of the other measured parameters of fitness the trend of association by quartile of number of push-ups appeared the most similar for males and females. For males the risks increased from a low of 13.6% for the quartile of trainees doing the most push-ups to 33.3% for those doing the least (see table 4b). For males none of the strata by decreasing number of push-ups was

significantly different than the baseline (those doing the most), but the trend was suggestive. For women the risk increased in the same manner from a low of 37.5% for those doing the most push-ups to 56.8% for those doing the least. For females, however these differences were marginally significant with an average risk of 54.5% for the lowest 3 quartiles versus 37.5% for the highest, a risk ratio of 1.45 ($p < .1$, see table 4a). In regard to sit-ups, although some levels or strata appeared to be at elevated risk from the baseline the patterns within and between genders were not consistent. Low levels of muscle endurance as measured by push-ups was possibly causally associated with risk of injury, while this could not be said for sit-ups.

Percent body fat as measured by skinfolds did not appear to be associated with injury for males or females, but body mass index (BMI) did. For both males and females both the lowest, "leanest", and highest or "fattest" quartiles appeared to be at increased risk of injury compared to the middle quartiles (see tables 4a and 4b). For both genders the risk of injury for the fattest quartile was significantly greater than the middle two. For males the risk for the fattest group by BMI was 38.7% compared to 18.0% for the average group, a risk ratio of 2.3 ($p < .1$, 90% CI, 1.2 to 3.9). The same contrast for females was 63% injured versus 42% for fat versus average, risk ratio 1.6 ($p < .1$, 90% CI, 1.1 to 1.6). How to explain the different pattern of association between body composition as estimated by skinfolds and BMI is not clear.

Height was not associated with injuries among males (see table 4b). but it was for females (see table 4a). Among women the third quartile by height was at the least risk of injury at 30.2% in comparison to 61.2% for the shortest

and 54.8% for the tallest. These contrasts of the short and tall female trainees versus those just above the median height were both marginally significant (see tables 4a).

Examination of subjectively reported measures of past and present physical fitness from the questionnaire indicates that none of the descriptors of past fitness are associated with injury for males or females. Neither more total years of exercise in the past or participation in varsity athletics imparted a protective effect on male or female trainees (see tables 5b for males and table 5a for females). For males however, one subjectively reported factor was causally associated with likelihood of injury, self-assessed activity level (see tables 5b and 6b). This was not true for females (see tables 5a and 6a). In males the risks for any injury by activity level rose from the baseline of 17.2% for the very active group to 25.5% for those simply active, to 35.1% for those of average activity level up to 42.2% for those who were not active. The contrast in risk between those who were "not active" or just "average" to those who were "active" or "very active" was 36.4% versus 22.5%, a risk ratio of 1.61 ($p < .1$, 90% CI, 1.0 to 2.6). When only injuries causing a day or more of restricted duty were considered risks rose in a similar fashion and the contrast between the two most inactive categories and the two most active ones was 36.4% versus 11.3%, a risk ratio of [illegible].23 ($p < .1$, 90% CI, 1.3 to 3.4, see table 6b). As discussed none of the self-report past or present fitness factors were associated with injuries among women (see tables 5a and 6a), while male trainees reporting lower activity levels on entry to the Army were at increased risk of injury(see tables 5 and 6).

3. Risk of injury for females versus males re-evaluated

As reported above unadjusted risks of injury by all definitions were greater for women than for men. It was also evident that for two of the fitness variables, mile time and push-ups, the pattern of risk for men and women were similar, increasing more or less steadily from the baseline, high fitness group, to those of lower fitness. It also appeared possible that these curves might overlap in the area of the least fit men and the most fit women. Because of this a chi-square test was performed to compare the risks of men and women who ran times between the median for men, 7.0 minutes, and the median for women, 9.7 minutes. The risks for women (n=73) were 32.9% versus 31.7% for the men (n=41), a risk ratio of 1.04 which did not approach significance (90% CI, .65 to 1.65) (see table 8). Subsequently, a Mantel-Haenzsel Chi-square test stratifying women and men by tertile of mile time (for combined genders) was performed with a resulting risk ratio of .93 which was also not significant ($p > .8$, and 95% CI, .4 to 2.3) (see table 9)). An MH chi-square was also performed stratifying by tertile of push-ups with a resulting risk ratio of 1.35 for women versus men ($p = .58$, 95% CI, .61 to 3.06).

Additionally, a stepwise logistic regression model for injury was developed which included as variables gender, age, race, athletic status, self-assessed activity level, percent body fat, tertile of push-ups, tertile of sit-ups and tertile of mile run time. The only two factors which entered the model as significant causes were mile run time and sit-ups. Furthermore, if fitness measures (mile time and sit-ups) were not included in the potential variables, then gender was the only variable to enter the model as significant. In summary, when men and women of comparable endurance and strength were compared there was no difference in their respective risks of injury.

4. Risk of illness for male and female trainees

The risks of making one or more sick call visits for illness were greater for women than men, 48.4% versus 35.4% with a risk ratio of 1.4 ($p = .03$, 95%CI: 1.1 to 1.8 see table 10). However, if gynecological complaints were excluded from the comparison the risks of illness for women versus men were the same 37.1% and 35.4%, respectively, (RR = 1.05, $p < .05$, 95% CI: 0.8 to 1.4, see table 10). The only specific illness for which a comparison was made was upper respiratory tract infections (URI). A similar percent of women and men reported on sick call with URIs, 26.3% versus 28.2% (RR= .9, 95% CI: .7 to 1.4, see table 10). Likewise slightly fewer women than men required hospitalization for URI because of a temperature greater than 100 degrees F and they lost slightly fewer days per week due to restriction (see table 10). Eighty two percent of the male complaints were secondary to URI compared to 73% for the females (see table 11). Other categories of illness reported were dermatologic (i.e. rashes, folliculitis etc.) and gastro-intestinal (i.e. gastritis, diarrhea etc.) conditions.

Since upper respiratory tract infections (URI) accounted for most of the morbidity, the remainder of the results on illness will focus on these complaints. The epidemic curves for URIs in males and females can be seen in figure 2. The distribution of URIs (figure 2) over time is similar for males and females, and dissimilar from the patterns for injuries (figure 1). The peak incidence of URIs occurred in the first two weeks for both men and women. Fifty one percent of all URIs among males and 45% of URIs for females occurred in the first two weeks as compared to less than 25% of all injuries in this period. The rate of URI sick call visits per week was 3.5 per 100 males and

3.2 per 100 females. The amount of morbidity from upper respiratory tract infections was similar for men and women.

Two fitness variables, mile time and activity level, were associated with risk of URIs for males, and one for females, activity level. Unlike the association of mile time with injury, only the slowest quartile of males was at elevated risk of suffering a URI, 57.9%, as compared to the faster three quartiles which averaged 20.0%, a risk ratio of 2.9 ($p < .1$, 90% CI, 1.1 to 3.9, see table 12b). Also for males the risks of URIs rose steadily from the baseline very active group at 17.2%, to 21.5% for the active one, to 35.1% for the average group, and 42.1% for the sedentary one. The relative risk for those who reported average activity or less compared to those who were very active was 2.1 (36.4% to 17.2%) which was marginally significant ($p < .1$, 90% CI, 1.00 to 4.4 see table 12b). For women the risks of a URI for the very active group were 12.1% compared to the average for the other three groups which was 29.4%, a risk ratio of 2.4 ($p < .1$, 90% CI, 1.1 to 5.4, see table 12). These data suggest that low levels of endurance and current activity are associated with a predisposition to have an upper respiratory tract illness during Army basic training.

5. Comparative morbidity from injury and illness

The amount of morbidity caused by injury compared to illness in this population of basic trainees appears to be about the same when frequency of clinic visits and cumulative incidence are used as measures. The frequency of visits for males and females combined was virtually the same for injury versus illness. Complaints of injury accounted for 202 sick call visits (Males = 55,

Females = 94), while 204 were attributable to illness (Males = 65, Females = 139). The combined risks of males and females were also similar for both types of complaint. The combined risk for injury was 41.3% compared to 43.2% for illness. When risks for injury and illness were compared separately for men and women, they were also quite similar (see table 2 for risks of injury, see table 10 for risks of illness). The average rates of weekly sick call visits for injury and illness are the same, 8.1 visits per 100 trainees per week for injury and 8.2 visits per 100 trainees per week for illness (see table 3 for rates of injury visits for males and females separately, and table 11 for separate rates of illness visits). However, risks and rates of visits only provide a partial picture of relative morbidity.

Examining the amount of morbidity in terms of days of medical restriction, the picture is quite different. Males and females combined suffered 579 days of limited duty secondary to injury (males = 99 days, females = 480 days), as compared to only 42 days of restricted duty due to illness (males = 19 days, females = 22 days). The rate of days of medical restriction for injury and illness were respectively 23.3 days of limited duty per 100 trainee-weeks and 1.7 days per 100 trainee-weeks, for injury versus illness. Thus, while the incidence of injury and illness was about the same, 41.3% versus 43.2%, a ratio of .96, rates of days of medical restriction per 100 trainee-weeks were substantially different from each other, 23.3 days versus 1.7, a ratio of 13.7 to 1. These data suggest that training-related injuries sustained during the basic training cycle are a matter of great concern to the Army.

DISCUSSION

1. Comparability of sample to other Army populations

As with all studies of an epidemiologic nature one of our primary concerns is to assure the validity of our results from both an internal and external standpoint. In this regard we feel that if anything our results may under represent the true level of risk for injury and illness in Army basic training populations and the effects of physical fitness may also be underestimated.

We suspect that our estimates are conservative because the 20 percent of individuals who were lost to follow-up among both males and females tended to be less fit as indicated by our prospective measures of fitness and body composition (see appendix 1). We also, know from other studies where it was possible to document the incidence of injury among those discharged that those soldiers who do not graduate are more likely to suffer injuries during training than their peers (Bensel, Ft Jackson Tech Report 1983; Jones unpublished data Ft Benning 1987). Also, those individuals who did not take the initial (diagnostic) physical training test were either already injured and missed the test due to medical restriction or were part of a semi-random process of assignment to details of one kind or another. Thus we feel that the least fit, most injury prone individuals were excluded from our analysis which reduced the likelihood of our demonstrating significant differences between groups. For this reason we feel that the significant differences in risk of injury and illness demonstrated between groups of varying fitness levels is a testimony to the real strength of association between low levels of fitness and higher risk within this population (internal validity).

2. Validity of sample injury incidence

We also feel that it is legitimate to generalize the results of this study at the very least to other populations of Army basic trainees (i.e. the results have external validity). In regard to the incidence of injury among basic trainees, the percent of males and females reporting one or more musculoskeletal injury in our study was similar to the percents reported by others(Bensel 1983, and Kowal 1980). We found that 51% of females and 27% of males reported an injury (RR=1.8), while Bensel reported that 42% of females (n=767) and 23% of males (n=2074) suffered similar musculoskeletal conditions (RR=1.8). Kowal found that 54% of the women (n=400) and 25% of men (n=770) in his study experienced these types of musculoskeletal maladies (RR=2.1). Reinker and Ozburne (1979) reported data on male and female trainees who exhibited a relative risk of injury of 2.2 to 1 (our calculation from their data). Thus it is apparent that the risks and relative risks of injury in our population were compatible with those reported in the existing literature. Parenthetically, the risk of injury for male trainees is very similar to that for high school athletes in sports like cross-country and track, but less than for football and wrestling (see Table 14).

It is more difficult to establish the comparability of our data on the incidence of sick call (outpatient clinic) visits for acute minor illnesses. This difficulty arises from the fact that records of such visits are not routinely tabulated and because few reports of such visits exist in the literature. For the most common complaint of illness in our study, upper respiratory tract infection, one recent study (Brundage 1988) based on a very large sample of all Army basic trainees over several years, suggests that our data are in fact compatible with what one would expect for basic training populations. Brundage reported (1988) that .56 trainees could be expected to

be admitted to the hospital for a febrile upper respiratory tract illness per 100 trainee-weeks. This admission rate was calculated based on 2,633,916 trainee weeks of observation which began at the time our trainees were in the training. The rate of admission for females in our study was .54 per 100 trainee-weeks, and for males it was .70 per 100 trainee-weeks - a combined rate of .60 admissions per trainee-week for males and females.

The epidemic curve of upper respiratory tract illness for our population is similar to the one depicted in Brundage's (1988) article for the post-adenovirus vaccine era (see Figure 2) with 51% of male URIs occurring in the first two weeks of training and 44% for females. Thus, it would appear that at least as far as acute respiratory illness is concerned our population of trainees is reasonably representative of the experience of trainees since 1984 the period when the adenovirus vaccines have been given year round.

The physical characteristics and fitness of the trainees observed are fairly representative of Army basic trainees in the last decade. The average height, weight, and percent body fat of our population is similar to those averages reported by others (Vogel 1986 and Patton 1980). Vogel (1986) reported that for female trainees (n=212) versus males (n=210) the average heights, weights, and percents body fat and their ratios were respectively, 162cm in height for females versus 175cm for males (ratio=.93); 59kg body weight for females versus 71kg for males (ratio=.83); and 28% body fat for females versus 16% for males (ratio=1.7). The ratios of mean values for these characteristics among the trainees we observed for females versus males were 163cm versus 175cm (ratio=.93) for height, =59kg versus 73kg (ratio=.81) for weight, and 25% versus 17% (ratio= 1.5) for percent body fat. Thus the

height, weight and relative stature of the trainees in our study were comparable to those reported for other populations of Army trainees.

3. Validity of sample fitness levels

In regard to fitness it is more difficult to establish comparability however because the routine measures of fitness have changed over the last decade. The endurance standard for instance has been extended from a 1 mile run to a 2 mile run, while the other components of the test have been either altered in form or deleted. Also, trainees now run in athletic shoes, whereas before 1983 they wore combat boots exclusively. Nevertheless, at least for endurance some degree of comparability can be established despite the growing emphasis on running as a mode of developing stamina and changes in the test situation itself. Bensel (1983) reported that the times for women trainees (n=767) versus men (n=2074) on a 1 and 1/2 mile run on the final PT test were 13.51 mins and 11.02 mins respectively. The average time per mile of Bensel's subjects was 9.0 mins for women and 7.3 mins per mile for men, a ratio of 1.24 to one. The ratio of one mile times calculated from Patton's (1980) test run data of the late 1970s was calculated to be 1.33 (my calculation 10.9 mins to 8.2 mins), a ratio comparable to that we observed, however trainees wore boots in the population studied by Patton. The women trainees we observed ran an average time per mile for on a mile run test of 9.7 mins and males 7.2 mins per mile, a ratio of 1.35 for women versus men. Thus the relative endurance performance of women and men in our study was similar to that reported elsewhere in the past (see table 1).

Based on the preceding discussion we concluded that our population of trainees is fairly representative of Army trainees over the last decade in regard to health, stature, and physical fitness. Furthermore, the relative fitness of males and females appears to have remained about the same. For this reason we believe that it is legitimate to extrapolate from our conclusions concerning the impact of physical fitness on the risks of injury and illness among the trainees we observed to other populations of Army trainees. Also, we feel that our conclusions represent a conservative estimate of the effects of fitness on the risks of injury for young men and women in general, since Army trainees are leaner and fitter than their counterparts in the U.S. population.

4. Impact of fitness on risks of injury

In regard to the impact of fitness on injury, the most significant finding of this study was the clear association between low levels of endurance and increased likelihood of injury for both males and females. The slowest half of male trainees experienced 2.8 times as many injuries as the fastest (see table 4b). Among women the slower ones suffered 1.7 times as many reportable injuries (see table 4a) Regardless of how restrictive or specific the definition of injury employed in the analysis the results for both males and females were that individuals exhibiting lower levels of endurance as measured by running performances experienced significantly more injuries(see tables 7b and 7A, respectively).

The impact of fitness on risk of injury was of such importance that when all other variables were controlled for using logistic regression gender was

no longer significantly associated with injury when mile run time was included in the model. Using Mantel-Haenszel Chi square techniques the relative risk of injury for women versus men in this study was reduced from 1.8 to .93 when stratified by tertiles of mile times (see table 9). This suggests that the difference in injury rates for men and women entering the Army can be explained by their different levels of fitness, however, it does not mean necessarily that through training women will reduce their risk to the same level as men. This assumes that the average woman can physiologically achieve similar levels of endurance as the average man. Certainly, if the progressive decrease in the times of elite women distance runners relative to men over the last decade is any indicator, it would seem reasonable that the excess relative risk of injury for women can at least be considerably reduced.

Although not significant in the univariate analyses, the only other variable that figured significantly in the causation of injury in our full logistic regression model other than mile run time was sit-ups. We suspect that this may be because sit-ups are not only a measure of abdominal strength but also in as much as the iliopsoas muscle (a hip flexor) is one of the primary muscle groups employed in this exercise, sit-ups may represent a surrogate measure of leg strength.

It makes a certain amount of intuitive sense that a weight-bearing test of endurance performance, running, and a marker for abdominal and leg muscle endurance, sit-ups would be most strongly associated with risks for injury in Army trainees. The bulk of the injuries to military trainees reported in the literature (Reinker 1979, Bensel 1976,1983, Kowal 1980) are lower extremity overuse injuries which are attributable to marching and running. Furthermore,

the most common physical stressors during Army basic training are walking, marching, and running. Unlike most other training activities these ones are inescapable. Thus once a lower extremity has been injured or is fatigued it cannot be rested without stopping all training, since walking and marching are not only a major training activity themselves but they are also the primary means of getting from one training activity to another. This being so it makes sense that individuals with greater innate stamina or developed endurance would be at lower risk of injury, since at any given level of marching or running performance the more fit will be subject to less physiologic "stress" relative to their absolute weight-bearing endurance capabilities. In addition those who have engaged in weight-bearing training in the past will presumably have developed not only higher relative cardiovascular endurance but also greater muscular endurance and skeletal strength (bone density) of the lower extremities. This would suggest that individuals exhibiting high aerobic fitness levels (fast run times) should be less susceptible to fatigue and more resistant to lower extremity structural failure (injury) than their less fit counter parts. We suspect that hypothetical explanations such as these will ultimately be found to underlie the association we have found between higher endurance (faster run times) and decreased risk of injury.

The published literature offers few studies to which our results can be compared. Kowal (1980) reported that low levels of physical fitness and lower leg strength were associated with greater risk of overuse injuries among women undergoing Army training. However, he did not clearly delineate the relationship between fitness and risk of injury. No other such military data is available.

The civilian literature also is not very helpful. Even for runners, one of the best studied physically active groups outside the military, there is little substantive information. In a recent review Powell et al (1986) state that they could find only two studies examining risk factors for running injuries in the literature that were designed and executed well enough to give credence from an epidemiologic perspective These were studies published by Pollock et al (1977) and Koplan et al (1982). Since that time two other well designed studies surveying running populations have been reported by Blair et al (1987) and Marti et al (1988). The primary finding of all four of these studies was that higher training mileage was associated with higher risk of injury for runners.

In 1986 Powell et al stated that the only well documented risk factor for running injuries was higher training mileage. This is mentioned because it should not be construed as contradictory to our finding that higher fitness (endurance) levels among Army trainees are associated with lower risks of injury. Running more miles is a means by which endurance (aerobic fitness) may be improved. Running mileage is a measure of the amount of training not fitness. The literature (Pollock 87, Koplan 82, Balri 87, Marti 88) suggests that there is a dose-response relationship between increasing running mileage and increasing injury rates. Therefore, improving aerobic fitness by running more miles entails a risk - a greater likelihood of suffering a musculoskeletal injury.

On the other hand, what our study demonstrated was the benefit of higher levels of fitness as measured by mile run performance. The benefit was that for individuals (trainees) exposed to the same amount (miles) and level

intensity of training those with higher levels of aerobic fitness experienced fewer injuries that their less fit army counterparts. This study also indicated that males who characterized themselves as very active were less prone to injury than their less active peers when exposed to the same Army training program.

Before moving on several other factors deserve discussion. It may surprise some that percent body fat did not enter the logistic regression model as a significant risk factor for injury. This may be especially surprising since the military training injury literature has implicated obesity as a risk factor for injury (Gilbert 1963, Bensel 1976, Kowal 1980). However, in a model including running performance as a variable the effect of percent body fat may already be accounted for in that more obese individuals will have slower run times relative to their physiologic potential. It should also be pointed out that percent body fat was not significantly associated with risk of injury at a univariate level either.

In regard to our other index of adiposity, BMI, this variable was not included in our logistic regression model for men and women combined, because when both genders are grouped together BMI is not reflective of relative adiposity unless a correction factor is added. This is because the BMIs for women are lower than for men even though women are on average fatter than men.

However, on a univariate level BMI was significantly associated with injury. It is also important to note that BMI has a complex relationship with risk of injury for both men and women having a bimodel distribution (see tables 4A and B). Men and women at both high and low extremes of BMI appeared

to be at increased risk of injury. This finding is consistent with results reported by Marti et all (1988) who observed a similar bimodel distribution of injuries versus BMI among the runners they surveyed. It may be that individuals with high BMIs are injury prone because they are carrying greater excess fat mass relative to their skeletal size and locomotory muscle mass, while those who are at the low end of BMI are susceptible to injury because they have a low total mass including too little muscle mass relative to their skeletal size. Further study is clearly needed to clarify the association between BMI and likelihood of suffering a training-related injury. Also, why BMI and percent body fat are such different predictors of injury is a puzzle deserving additional exploration.

Height is another factor worth mentioning briefly. It is noteworthy that it has been felt for some time in military training and medical circles that short stature is a risk factor for injury to women (Reinker 1979, and personal communications). As a result it has been recommended that short women march at the front of columns in training. Interestingly, we found that both short and tall women were at significantly increased risk of injury (see table 4a). While a significant association was not found for men in our study the pattern of injury in relation to height was similar to that for women.

5. The impact of gender and fitness on risks of illness

In regard to non-injury-related complaints U.S. population data suggests (DHHS 1984), women are more likely to request or seek attention for illness than men. In Health United States 1984 the Department of Health and Human Services (DHHS) reported that on average there were 2.95 physician visits per

woman nation wide compared to 2.19 visits per man in 1981. The ratio for health visits for women versus men nationally was 1.39 in that survey. In our study the ratio of risks (cumulative incidence) for illnesses of women versus men was 1.35 (48.4% versus 35.4%). Thus the relative risks for illness among the women we observed appeared very similar to what one would expect based on national data.

If as we indicated in the results we compared the risks of illness for men and women including only those ailments they share in common (i.e., non-gynecological complaints) there was little or no difference in their risks. Excluding gender specific, gynecological, complaints the relative risk for illness of women versus men was 1.05 (37.1% versus 35.5%) (see table 10). If a similar correction is made on the DHHS data by subtracting known gynecological visits and presumed gynecological visits from the family and general practice visits, then the ratio of annual female to male visits becomes 1.09 (2.4 visits per woman per yr versus 2.2 visits per male per year). What these statistics suggest is that females have few medical conditions in excess of males if complaints of illness peculiar to their gender are excluded. Thus it would appear that if the Army is interested in reducing the amount of morbidity among females relative to males attention must be focused on prevention of genito-urinary tract and other medical conditions for which women have a vulnerability.

Comparing the risks of men and women for the most common illness reported during basic training, upper respiratory tract infections (URIs), it appears that they suffer about the same number of such complaints and loose similar amounts of time due to these conditions (see table 10). If anything it

appears that women are hospitalized at a slightly lower rate than men for URIs.

Examining risk factors for URIs it appeared that both men and women with high self-assessed physical activity levels experienced a lower incidence of infections (see tables 12a and b). For men the slowest quartile on the mile run suffered more URIs than the other three quartiles, indicating that higher endurance is some how protective (table 12b). As an explanation, it might be that those individuals who have been more active and are in better physical condition are subject to lower relative levels of physiologic stress and may therefore be less prone to immunologic suppression secondary to stress. This is speculative, however, since the nature of the impact of exercise and fitness on the immune system is not well established at this time (Simon 1984, 1987, Tomasi 1981). While it can be said with somewhat greater surety that viral illnesses have a detrimental impact on physical and sports performance, even this relationship needs further investigation (Roberts 1986, Daniels 1985, Friman 1985). It would appear that the military would have a vested interest in pursuing research in this area, because of the strong emphasis on physical conditioning and performance, and the vulnerability of troops to disease, especially respiratory tract complaints.

6. Relative importance of injury and illness as causes of morbidity

Information on past and present trends in the distribution and pattern of disease and injury among military personnel is essential to planning strategies for the treatment and prevention of casualties in future military operations. Such information is also crucial for estimating the impact of

casualties on military preparedness and likely effectiveness. The data used for such projections is usually hospital admission rates and mortality rates. Hoeffler has suggested that these statistics are inadequate, however, and that unless data on outpatient care is included morbidity especially from injury may be severely underestimated (Hoeffler 1981).

Although infectious disease is still a major cause of morbidity especially in combat situations, there has been a trend of decreasing relative importance for infectious diseases in both peacetime and combat military populations (Reister 1975, DoD 1982, Hoeffler 1981, Health of the Army 1968-1972). The Army hospitalization rate for all injuries and accidents (Health of the Army) in 1981 was 24.5 per 1000 troop-years, whereas the rate of admission for infectious disease was 10.6 per 1000 troop-years, a risk ratio for injury versus infection of 2.3 to 1. In terms of non-effectiveness the rates were 13.0 days on the hospital rolls per 10,000 man-days due to injury versus 1.9 days, due to infectious disease, a ratio of 6.8 to 1 in terms of days of lost manpower. When we restricted the examination of injuries to those related to physical activity and training, and sports, the rates of hospitalization secondary to physical activity-related injuries were less than for infectious disease, but non-effective rates were higher by a factor of 2 (3.8 days per 10,000 troop-days versus 1.9, see table 3). These data are consistent with civilian data that indicate that injuries are the primary cause of morbidity and mortality in young populations (19-45), especially for males (CDC 1986). These rates of hospital admissions do not give as clear a picture of the true relative importance of injury as a cause of morbidity as do outpatient data.

Our data on sick call visits are consistent with the findings of Hoeffler (1981) that suggest that outpatient data are needed in order to assess the relative impact of injury and disease on the health of soldiers. In our study 15 trainees were hospitalized for illnesses for a total of 41 days of restricted duty. However, 14 times as many days of limited duty (579) were accrued secondary to injuries as for illness. Stress fractures <u>alone accounted</u> for <u>more</u> days of limited days (133 days) than all illnesses. These findings are consistent with similar data from other training posts (unpublished data). Thus, it seems clear that in peacetime Army training populations like the one we observed, injury is the greatest cause of lost duty time.

To a large extent the apparent importance of injury as a cause of morbidity is probably due to the success of effective treatment and prevention strategies against infectious diseases developed over the last 100 years. We are able to treat and prevent many infectious disease, largely because of a consistent and on-going research effort into the epidemiology and biology of these diseases by both military and civilian scientists. However, at this time there is no consistent research devoted to the epidemiology and causation training-related injuries in the Army. Successful injury prevention programs depend upon research to identify risk factors and to test interventions. A greater commitment to injury research may well be rewarded with success similar to that in the area of infectious disease.

<u>Summary</u>

It is clear that in the population of trainees we observed injury was not only an important cause of morbidity, it was the most debilitating cause. We found that the most important intrinsic factor associated with injury was level of aerobic performance as measured by mile run times for both males and females. In fact, if mile run times were taken into account, injury rates for women were similar to men of comparable aerobic fitness. Other risk factors associated with injury on a univariate level for males were body mass index with increased risk among those with the highest and lowest indexes, and past activity level with those who were active prior to enlistment being at less risk than those who were not. For women low numbers of pushups, low numbers of sit-ups, high and low body mass index and short and tall stature were associated with injury on a univariate level. Thus, the overall picture was one of an association between low levels of physical fitness and increased risk of injury for both males and females. This was borne out by our multivariate, logistic regression model. Because of the small sample size for males and females, we feel further study should be conducted to establish the degree of association between fitness and injury and to control for the effect of different levels of training.

As with injury it also appeared that to some extent there was an association between lower levels of fitness and illness. However, the primary finding in regard to illness was that when the incidences of illness for women and men is compared for conditions to which both genders are susceptible the risks are the same. Both these findings deserve further study.

SUMMARY of CONCLUSIONS

1. Training-related injuries are one of the most important causes of morbidity in Army basic training populations, and are the leading cause of limited duty due to medical restriction.

2. Female trainees suffer nearly twice as many training related injuries as males.

3. Low levels of physical fitness, especially endurance performance, predispose individuals to increased risk of training-related injury. In fact, the large difference in injury risk between male and female trainees can be attributed to differences in their levels of fitness.

4. Further epidemiologic and carefully controlled intervention studies are required to evaluate the impact of the training program itself on the risks of injury.

5. Risks for illnesses, like upper respiratory infections, for which women have no special predisposition, are the same for male and female trainees.

6. Very low levels of physical fitness and activity predispose individuals to greater likelihood of upper respiratory tract infections.

7. Modulation of physical training to accommodate individuals or groups of individuals of different fitness levels may help to prevent injuries and to a lesser extent illnesses like upper respiratory tract infections.

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TABLES

TABLE 1. DESCRIPTIVE CHARACTERISTICS AND PHYSICAL FITNESS TEST RESULTS OF MALE AND FEMALE ARMY TRAINEES

Variable	Females			Males			P-value
1. Descriptive Characteristics							
	n	Mean	(+SD)	n	Mean	(+SD)	
Age (Yrs)	186	21.2	(3.58)	124	20.2	(2.7)	0.0084*
Ht (cm)	186	163.3	(6.58)	123	175.2	(6.62)	0.0000*
Wt (kg)	186	58.7	(5.76)	124	73.6	(10.90)	0.0000*
BMI (Wt/Ht^2)	186	22.4	(1.97)	123	24.3	(3.1)	
%BF (%)	186	25.2	(9.36)	124	16.9	(4.85)	0.0000*
Yrs Ex (Yrs)	186	3.5	(4.5)	124	4.5	(4.0)	0.049*
2. Initial Fitness Test (1st Week)							
Mile Time (Min)	140	9.73	(1.36)	79	7.19	(1.01)	0.0000*
Sit-ups (n)	163	37.9	(11.9)	98	54.5	(13.8)	0.0000*
Push-ups (n)	138	12.4	(9.9)	97	31.0	(9.3)	0.0000*
3. Final Fitness Test (7th Week)							
2 Mile Time (mi)	154	18.08	(1.49)	101	14.41	(1.44)	0.0000*
Sit-ups (n)	155	49.9	(10.3)	101	53.9	(9.4)	0.0014*
Push-ups (n)	152	18.0	(7.1)	101	36.9	(10.1)	0.0000*

* Difference between females and males significant at P<.05.

TABLE 2 RELATIVE RISKS* (RR)** OF MUSCULOSKELETAL INJURY FOR FEMALES VERSUS MALES DURING 8 WEEKS OF ARMY BASIC COMBAT TRAINING

Type injury	Female Risks (n=186) (%)	Male Risks (n=124) (%)	RR	95% CI
All injury	50.5	27.4	1.84	(1.34 - 2.54)+
Lower extremity injury	44.6	20.9%	2.13	(1.46 - 3.10)+
Stress Fractures or reactions	11.3%	2.4%	4.71	(1.42 - 15.31)+
Injury causing day or more of restricted duty	30.1%	20.2%	1.49	(.99 - 2.26)
Number of Restricted Days for Injury per 100 person weeks	32.3days	10.0days	-	-

* RISK = Cumulative Incidence = Percent with 1 or more sick calls for musculoskeletal complaints over 8 week cycle.

** RR=*Relative risk - Risk of females x (Risk of males)$^{-1}$.

+ Significant at p<.05.

TABLE 3 FREQUENCY AND DISTRIBUTION (%) OF INJURIES BY TYPE FOR ALL SICK CALL VISITS FOR MALE (n=124) AND FEMALE (n=186) TRAINEES DURING 8 WEEKS OF BASIC TRAINING

Type Injury	Females n (%)	Males n (%)
Musculoskeletal Pain	55 (37.4)	18 (32.7)
Low Back Pain	3 (3.4)	9 (16.4)
Tendonitis	10 (6.8)	8 (14.5)
Sprain	11 (7.5)	6 (10.9)
Stress Fracture	29 (19.7)	4 (7.4)
Muscle Strain	24 (16.3)	3 (5.5)
Overuse Knee Pain	5 (3.4)	1 (1.8)
Blisters	6 (4.1)	1 (1.8)
Other	4 (2.7)	5 (9.1)
TOTAL	147(100.0)	55(100.0)
Injury Sick Call Per 100 trainees per week	9.9	5.5

TABLE 4A. RELATIVE RISKS OF INJURY* BY QUARTILE (Q) FOR MEASURED LEVELS of FITNESS AND STATURE AMONG FEMALE ARMY TRAINEES

Fitness Variable	Risk %	Relative Risk (vs Baseline)+	(n)	Confidence Interval (90% CI)
Mile Time (Median=9.75min)			140	
Q_1 Fast	36.1	1.08	(36)	(.64-1.84)
Q_2	+33.3	1.00	(36)	----
Q_3	57.1	1.71	(35)	(1.09-2.71)**
Q_4 Slow	60.6	1.82	(33)	(1.16-2.86)**
Slow($Q_{3,4}$)vsFast($Q_{1,2}$)		1.76		(1.24-2.32)**
Push-Ups (Median=11)			138	
Q_1 High	+37.5	1.00	(32)	----
Q_2	48.5	1.29	(33)	(.82-2.16)
Q_3	58.3	1.55	(36)	(1.03-2.50)**
Q_4 Low	56.8	1.51	(37)	(1.00-2.44)**
Low($Q_{2,3,4}$)vsHigh(Q_1)		1.45		(1.00-2.26)**
Sit-Ups (Median=39)			163	
Q_1 High	+35.0	1.00	(40)	----
Q_2	54.1	1.55	(37)	(1.00-2.38)**
Q_3	58.1	1.66	(43)	(1.10-2.51)**
Q_4 Low	48.8	1.39	(43)	(.90-2.16)
Low($Q_{2,3,4}$)vsHigh(Q_1)		1.53		(1.05-2.24)**
Percent Body Fat (Median=25.2%)			185	
Q_1 Lean	41.3	.78	(46)	(.54-1.12)
Q_2	61.7	1.16	(47)	(.86-1.56)
Q_3	53.2	1.00	(47)	----
Q_4 Fat	45.7	.86	(46)	(.61-1.21)
BMI (Wt/Ht^2) (Median=22.5)			186	
Q_1 Lean	55.6	1.45	(45)	(1.00-2.11)**
Q_2	45.8	1.20	(48)	(.80-1.78
Q_3	+38.3	1.00	(47)	----
QA_4 Fat	63.0	1.64	(46)	(1.15-2.35)**
Fastest(Q_4vs"Average"($Q_{2,3}$)				(1.13-1.94)**
Height (Median=163.4 cm)			186	
Q_1 Short	61.2	2.03	(49)	(1.32-3.10)**
Q_2	53.8	1.78	(52)	(1.15-2.75)**
Q_3	+30.2	1.00	(43)	----
Q_4 Tall	54.8	1.87	(42)	(1.16-2.83)**

*Injury = 1 or more sick call visits for a musculoskeletal complaint during 8 week Basic Combat Training Cycle.
** Denotes that the risk ratio of the quartile of interest x (baseline quartile)$^{-1}$ is significant at P<.1.
+ Denotes referent or baseline level (denominator) for relative risks.

TABLE 4B. RELATIVE RISKS OF INJURY* BY QUARTILE (Q) FOR MEASURED LEVELS of FITNESS AND STATURE AMONG MALE ARMY TRAINEES

Fitness Variable	Risk %	Relative Risk (vs Baseline)+	(n)	Confidence Interval (90% CI)
Mile Time (Median=7.0 mins)			79	
Q_1 Fast	14.3	1.43	(21)	(.35- 5.86)
Q_2	+10.0	1.00	(20)	----
Q_3	26.3	2.63	(19)	(.74- 9.30)
Q_4 Slow	42.1	4.21	(19)	(1.28-13.83)**
Slow($Q_{3,4}$)vsFast($Q_{1,2}$)		2.81		(1.28- 6.13)**
Push-Ups (Median=31)			97	
Q_1 High Number	+13.6	1.00	(22)	----
Q_2	25.0	1.84	(24)	(.68-5.28)
Q_3	33.3	2.45	(27)	(.91-6.58)
Q_4 Low Number	33.3	2.45	(24)	(.90-6.66)
Low($Q_{2,3,4}$)vsHigh(Q_1)		2.45		(.95-6.26)
Sit-Ups (Median=52)			98	
Q_1 High Number	+17.4	1.00	(23)	----
Q_2	32.0	1.84	(25)	(.76-4.47)
Q_3	19.2	1.10	(26)	(.41-3.00)
Q_4 Low Number	37.5	2.16	(24)	(.91-5.12)
Percent Body Fat (Median=16.6%)			123	
Q_1 Lean	27.3	1.29	(33)	(.62-2.65)
Q_2	26.7	1.26	(30)	(.60-2.64)
Q_3	+21.2	1.00	(33)	----
Q_4 Fat	35.7	1.68	(28)	(.84-3.36)
BMI (Wt/Ht^2) (Median=23.7)			124	
Q_1 Lean	35.5	2.06	(31)	(.94-4.48)
Q_2	18.8	1.10	(32)	(.44-2.68)
Q_3	+17.2	1.00	(29)	----
QA_4 Fat	38.7	2.25	(31)	(1.04-4.83)**
Fast(Q_4)vs"Ave BF"($Q_{2,3}$)		2.14		(1.20-3.85)**
Height (Median=175.4cm)			123	
Q_1 Short	29.0	1.20	(31)	(.66-2.38)
Q_2	+24.2	1.00	(33)	-----
Q_3	27.0	1.12	(37)	(.57-2.19)
Q_4 Tall	31.8	1.31	(22)	(.64-2.70)

*Injury = 1 or more sick call visits for a musculoskeletal complaint during 8 week Basic Combat Training Cycle.

** Denotes that the risk ratio of the quartile of interest x (baseline quartile)$^{-1}$ is significant at P<.1.

+ Denotes referent or baseline level (denominator) for relative risks.

TABLE 5A RELATIVE RISK OF INJURY* BY LEVEL OF HISTORICAL ACTIVITY OR SPORTS PARTICIPATION FROM SURVEY QUESTIONNAIRE GIVEN TO FEMALE ARMY TRAINEES

Activity or Sports (Level)	Risk (%)	Relative Risk (vs baseline)+	(n)	Confidence Interval (90% CI)
1) Self Assessed Activity Level			186	
Very Active	48.5	1.00	(33)	----
Active	52.2	1.08	(69)	(.84-1.31)
Average	48.4	1.00	(64)	(.56- .96)
Not Very Active	55.0	1.14	(20)	(.57-1.21)
2) When Active			186	
Current	51.3	1.00	(119)	----
Past	47.9	.93	(48)	(.70-1.25)
Never	52.6	.98	(19)	(.70-1.51)
3) Years Exercise			186	
>4 Years	53.3	1.00	(45)	----
1.0-4.0 Years	47.1	.89	(39)	(.65-1.21)
<1.0 Years	52.1	.98	(73)	(.73-1.31)
4) Athletic Status			186	
Varsity Athlete	52.0	1.00	(75)	----
Non-Varsity Athlete	41.4	.80	(58)	(.58-1.09)
Non-Participant	58.5	1.13	(53)	(.86-1.46)

*Injury = 1 or more sick call visits for a musculoskeletal complaint during 8 weeks of Basic Training.
+Denotes referent or baseline (denominator) level for relative r

TABLE 5B RELATIVE RISK OF INJURY* BY LEVEL OF HISTORICAL ACTIVITY OR SPORTS PARTICIPATION FROM SURVEY QUESTIONNAIRE GIVEN TO MALE ARMY TRAINEES

Activity or Sports (Level)	Risk (%)	Relative Risk (vs baseline)+	(n)	Confidence Interval (90% CI)
1) Self-Assessed Activity Level			124	
Very Active	17.2	1.00	(29)	----
Active	25.5	1.48	(51)	(.68-3.21)
Average	35.1	2.04	(37)	(.95-4.37)
Not Very Active	42.9	2.49	(7)	(.93-6.63)
(Not Act+Avg)vs(Act+V.Act)		1.61		(1.01-2.59)**
2) When Active			1[illegible]	
Currently	25.6	1.00	(90)	----
Past	31.3	1.22	(32)	(.78-2.19)
Never	50.0	1.95	(2)	(.59-6.50)
3) Years of Exercise (regular exercise, >3 times/wk)			124	
>4 Years	24.0	1.00	(50)	----
1-4 Years	30.0	1.25	(43)	[illegible]
<1 Year	29.1	1.21	(31)	(.65-2.25)
4) Athletic Participation				
Varsity Athlete	29.4	1.00	(68)	----
Non-Varsity Athlete	24.4	.83	(41)	(.48-1.43)
Non-Participant	26.7	.89	(15)	(.42-1.96)

*Injury = 1 or more sick all visits for a musculoskeletal complaint.

** Denotes that relative risk of quartile of interest x (baseline quartile)$^{-1}$ is significart at $p<.1$.
+Denotes referent or baseline (denominator) level for relative risk.

TABLE 6A RELATIVE RISK (RR)* BY FITNESS LEVEL OF A MUSCULOSKELETAL INJURY RESULTING IN A MEDICAL RESTRICTION OF DUTY FOR 1 DAY OR MORE FOR FEMALE TRAINEES

Females

Mile Time	Risk (%)	RR* (Q_i/Q_R)	90%CI (range)	(n)
				140
Q_1Fast	19.4	1.16	(.51-2.67)	(36)
Q_2	16.7	1.00	--	(36)
Q_3	40.0	2.40	(1.19-4.84)	(35)**
Q_4 Slow	36.4	2.18	(1.06-4.49)	(33)**
Fast($Q_{1,2}$)vsSlow($Q_{3,4}$)		2.12	(1.30.3.44)	**
Push Ups				
				138
Q_1High	28.1	1.00	--	(32)
Q_2	33.9	1.21	(.6-2.06)	(33)
Q_3	38.9	1.38	(.75-2.38)	(36)
Q_4Low	24.3	.86	(.43-1.63)	(37)
Low($Q_{2,3,4}$)vsHigh(Q_1)		--	--	
BMI				
				186
Q_1 Lean	35.6	1.53	(.88-2.62)	(45)
Qb2	29.2	1.26	(.70-2.20)	(48)
Q_3	23.2	1.00	--	(47)
Q_4 Fast	37.0	1.59	(.92-2.79)	(46)
Fat(Q_4)vs"Normal"($Q_{2,3}$)		1.41	(.92-2.15)	
Self-Assessed Activity Level				
				186
Very active	30.7	1.00	--	(33)
Active	33.3	1.08	(.66-1.84)	(69)
Average	29.7	.97	(.57-1.68)	(64)
Not very active	30.0	.98	(.49-2.01)	(20)

*Relative risk=risk of the group of interest x (risk of the referent group)$^{-1}$ = QI/QR

**Signifies significant at p<.1 (i.e. 90% CI does not encompass 1).

TABLE 6B. RELATIVE RISK (RR) BY FITNESS LEVEL OF A MUSCULOSKELETAL INJURY RESULTING IN A MEDICAL RESTRICTION OF DUTY FOR 1 DAY OR MORE FOR MALE TRAINEES

Males

Mile Time	Risk (%)	RR* (Q_I/Q_R)	90%CI (range)	(n)
				79
Q_1Fast	00.0	--	--	(21)
Q_2	0.0	--	--	(20)
Q_3	21.1	--	--	(19)
Q_4 Slow	36.8	--	--	(19)
Fast($Q_{1,2}$)vsSlow($Q_{3,4}$)			(p=.003)	**
Push-Ups				
				97
Q_1High	4.5	1.00	--	(22)
Q_2	25.0	5.56	(1.0-30.38)	(29)
Q_3	22.2	4.93	(.88-27.11)	(27)
Q_4Low	20.8	4.62	(.81-25.99)	(24)
Low($Q_{2,3,4}$)vsHigh(Q_1)		4.99	(.96-25.8)	
BMI				
				123
Q_1 Lean	25.8	1.87	(.75-4.66)	(31)
Q2	9.4	.68	(.21-2.22)	(32)
Q_3	13.8	1.00	--	(29)
Q_4 Fast	32.3	2.34	(.97-5.61)	(31)
Fat(Q_4)vs"Normal"($Q_{2,3}$)		2.81	(1.36-5.80)#	
Self-Assessed Activity Level				
				124
Very active	3.4	1.00	--	(24)
Active	15.7	4.56	(.83-24.96)	(51)
Average	35.1	10.19	(1.94-53.46#	(37)
Not very active	42.9	12.43	(2.12-72.87)#	(7)
($\leq$Avg)vs($\geq$Active)		3.23	(1.74-5.96)#	

* Relative risk = risk of the group of interest x (the risk of the referent group)$^{-1}$ = Q_I/Q_R

** Fisher's exact test p-value = .003

Significant at p<.1, i.e. 90% CI doesnot encompass 1.

TABLE 7A. RELATIVE RISKS (RR)* OF LOWER EXTREMITY (LE) INJURIES AND STRESS FRACTURE BY FITNESS LEVEL FOR FEMALE TRAINEES

LE INJURY

		Females		
Mile Time	Risk %	RR (Q_I/Q_R)	90%CI (range)	n
				140
Fast	30.5	1.00	-	(72)
Slow	54.4	1.78	(1.3-2.5)**	(68)

LE STRESS FRACTURE

Mile Time	Risk %	RR	90% CI	n
				140
Fast	6.9	1.00	-	(72)
Slow	17.6	2.54	(1.1-5.8)**	(68)

*Relative Risk = RR = Risk of group of interest (Risk of referent group)$^{-1}$ =QI/QR.

**Denotes that risk ratio of group of Slow versus Fast is significant at p<.1, i.e., 90% CI does not encompass 1.

TABLE 7B. RELATIVE RISKS (RR)* OF LOWER EXTREMITY (LE) INJURIES and STRESS FRACTURE BY FITNESS LEVEL FOR MALE TRAINEES

LE INJURY

		Males		
Mile Time	Risk %	RR (Q_I/Q_R)	90%CI (range)	n
Fast	9.7	1.00	-	(40)
Slow	28.9	2.97	(1.2-7.2)**	(38)

LE STRESS FRACTURE

Mile Time	Risk %	RR	90% CI	n
Fast	0.0	-	-	(40)
Slow	4.8	-	-	(38)

Relative Risk = RR = Risk of group of interest(Risk of referant group)$^{-1}$ =QI/QR.

**Denotes that risk ratio of group of Slow versus Fast is significant at p<.1, i.e., 90% CI does not encompass 1.

TABLE 8. RISKS of INJURY for ARMY TRAINEES* RUNNING MILE TIMES BETWEEN MEDIAN FOR MALES (7.00 MIN) AND MEDIAN FOR FEMALES (9.7 mins)

FEMALES(n = 73) (%)	MALES(n = 41) (%)	RR (90% CI)	P
32.9	32.7	1.04 (.65-1.65)	n.s.

* Fort Jackson 1984

TABLE 9. STRATUM SPECIFIC RISKS of INJURY FOR FEMALES VERSUS MALES BASED on TERTILES of MILE RUN TIMES

TERTILE* of Mile Time	FEMALES % (n_i/n_t)**	MALES % (n_i/n_t)**	RR(95% CI
1	20.0 (2/10)	17.5 (11/63)	1.14(.3-4.5)
2	37.3 (22/59)	46.7 (7/15)	.80(.4-1.5)
3	57.7 (41/71)	0.0 (0/1)	-- (-----)

MH-Summary Risk Ratio = .98
MH-CHI SQ = 0.00, P = 1.00

*T_1 = 5.9-7.9 min, T_2 = 7.9-9.7 min, T_3 >9.7 min

**n_i = # injured, n_t = total # in stratum

TABLE 10. RELATIVE RISKS (RR) FOR ILLNESSES FOR FEMALES VERSUS MALES DURING 8 WEEKS OF ARMY BASIC TRAINING WITH 95% CONFIDENCE INTERVALS (95% CI)

	FEMALES RISKS (%)	MALE RISKS (%)	RR	95% CI (RANGE)
All Illness	48.4	35.4	1.37	(1.1-1.8)+
Illness Minus GYN* Complaints	37.1	35.4	1.05	(.8-1.4)
URIs**	26.3	28.2	0.93	(.7-1.4)
URIs With 1 or More Days Med Restriction	4.3	5.6	0.78	(.3-2.1)
Number of Days Med Restrictions for URI Per 100 Trainees Per Week	1.5 days	1.9 days	--	------

*GYN Complaints - Conditions such as Vaginitis, Anovulatory Cycle, Birth Control Evaluation, Cystitis, etc.

**URI - Complaints Compatible with Upper Respiratory Tract Infection, i.e., Colds, "Flu", Strep Throat etc.

+ Significant $P<.05$.

TABLE 11. FREQUENCY AND DISTRIBUTION (%) OF ALL SICK CALL VISITS FOR ILLNESSES AMONG MALE (n=124) AND FEMALE (n-186) TRAINEES DURING 8 WEEKS ARMY BASIC TRAINING

Type Visit	Females	Males
	n(%)	n (%)
Upper Respiratory Tract Infection (URI)	72 (72.7)	53 (81.5)
Dermatological	7 (7.0)	4 (6.1)
Gastrointestinal	6 (6.1)	3 (4.6)
Other	14 (14.1)	5 (7,7)
TOTAL[1] (Non-Gyn)	99(100.0)	65(100.0)
Gynecological (Gyn)	39(139.0)	-- --
TOTAL[2](With GYN)	138(139.0)	65(100)
Non-Gyn Illness Sick Calls per 100 Trainees per wk*	6.7	6.6
Gyn Sick Calls per 100 Trainees per wk	2.6	-- --
Illness Sick Calls per 100 Trainees per wk Including Gyn Visits.	9.3	6.6

* Gynecological complaints = conditions reported on sick call such as vaginitis, cystitus, menstrual complaints, etc.

TABLE 12A. RELATIVE RISKS* (RR) OF AN UPPER RESPIRATORY TRACT INFECTION BY FITNESS LEVEL FOR FEMALE ARMY TRAINEES WITH 90% CONFIDENCE INTERVALS (90% CI).

FITNESS MEASURES	FEMALES			
Mile Time	Risk %	RR*	90% CI (range)	(n) 140
**Q1 Fast	25.0	1.00	---	(36)
Q2	19.4	.78	(.37-1.62)	(36)
Q3	17.1	.68	(.32-1.49)	(35)
Q4 Slow	30.3	1.21	(.64-2.31)	(33)
Self-Assessed Activity Level				186
**Very Active	12.1	1.00	---	(33)
Active	26.1	2.16	(.93-4.99)	(69)
Average	34.4	2.84	(1.25-6.45)+	(69)
Not Active	25.0	2.07	(.76-5.61)	(20)
<Act vs V.Act			(1.09-5.39)+	

*Risk - cumulative incidence - percent injured; relative risk - injury risk in comparison level of fitness divided by the injury risk in the referant level.

**Baseline (referant) level for comparisons.

+90% CI of these levels does not include one, so these levels can be considered significant at p<.10.

TABLE 12B. RELATIVE RISKS* (RR) OF AN UPPER RESPIRATORY TRACT INFECTION BY FITNESS LEVEL FOR MALE ARMY TRAINEES WITH 90% CONFIDENCE INTERVALS.

FITNESS MEASURES		MALES		
Mile Time	Risk %	RR*	90% CI (range)	(n) 79
**Q_1 Fast	19.0	1.00	---	(21)
Q_2	20.0	1.04	(.37-2.98)	(20)
Q_3	21.1	1.11	(.39-3.13)	(19)
Q_4 Slow	57.9	3.05	(.98.5.24)	(19)
Slow(Q_4) vs Fast($Q_{1,2,3}$)			(1.14-3.89+)	
Self-Assessed Activity Level				124
**Very Active	17.2	1.00	---	(29)
Active	21.5	1.60	(.93-4.23)	(51)
Average	35.2	2.04	(.95-4.37)+	(37)
Not Active	42.9	2.44	(.93-6.63)	(7)
(<Act vs V.Act)			(1.00-4.44)+	

*Risk = cumulative incidence = percent injured; relative risk = injury risk in comparison level of fitness divided by the injury risk in the referant level.

**Baseline (referant) level for comparisons.

+90% CI of these levels does not include one, so these levels can be considered significant at p<.10.

TABLE 13. ARMY WIDE COMPARATIVE MORBIDITY FROM INFECTIOUS AND PARASITIC DISEASE VERSUS PHYSICAL ACTIVITY ASSOCIATED INJURIES* FROM COMPUTERIZED HOSPITALIZATION RECORDS**

	INFECTION	INJURY*
Number hospitialized (n/yr)	8200	5100
Case rate (n/1000 man-yrs)	10.6	6.7
Non-effective rate (days/10,000 man-days)	1.9	3.8
Total hospital days (days/year)	53,000	110,000

* Physical Activity-Associated injuries - Injuries from Army Individual Patient Data System coded as Athletic and Sports accidents, marching and drilling, falls or jumps, twisting or turning, lifting, pushing or pulling accidents.

**Based on 1981 hospital (IPDS) data from Health of the Army Supplements on Infectious and Parasitic Diseases and on Injury.

TABLE 14. RISK (%) OF INJURY IN MALE ARMY TRAINEES AND HIGH SCHOOL ATHLETES

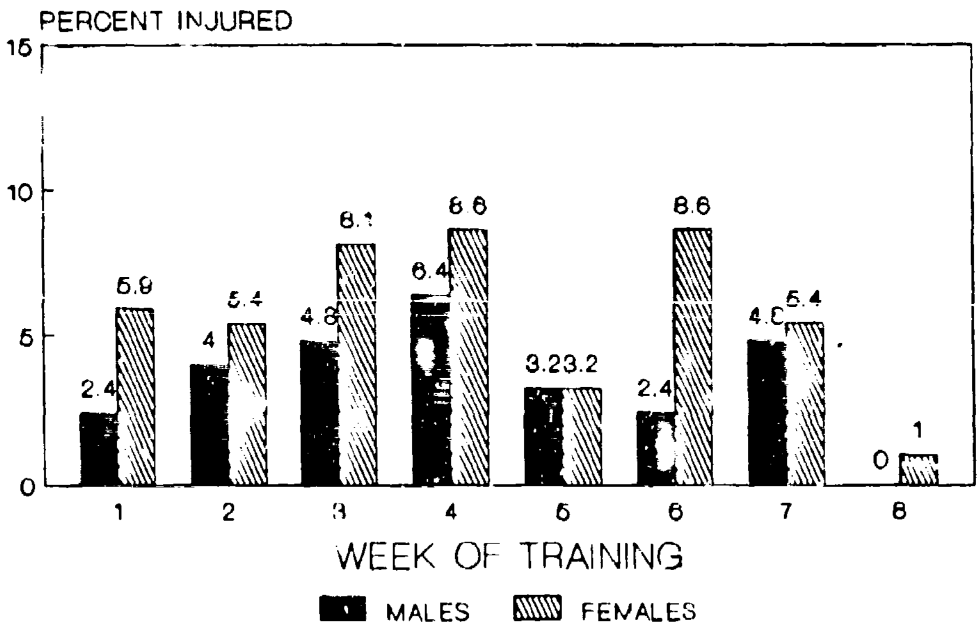
ACTIVITY	%INJURED (%)	DURATION** (WKS)	AVG% /WK
* ARMY BT	28	8	3.5
**ARMY BT	26	8	3.3
+ FOOTBALL HS	81	16	5.0
+ WRESTLING HS	75	12	6.3
+ TRACK HS	33	12	2.8
+ X-COUNTRY	29	12	2.4
+ BASKETBALL	31	12	2.6

*DZIADOS 1986; **BENSEL 1983; +GARRICK 1978

** DURATION = LENGTH OF SEASON IN WEEKS

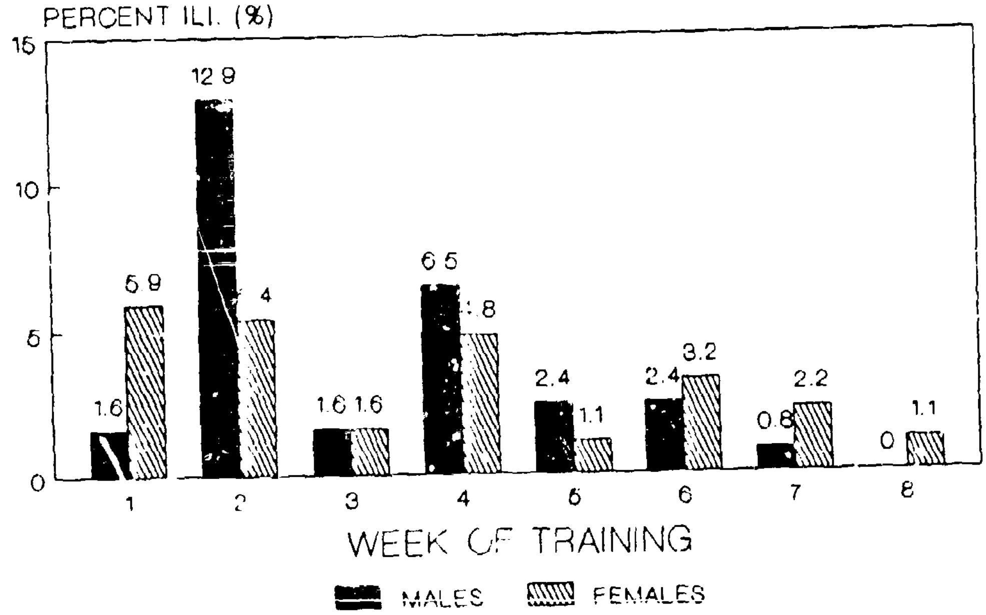
FIGURES

FIGURE 1. RISKS OF 1ST INJURIES BY WEEK FOR MALE AND FEMALE ARMY TRAINEES DURING 8 WEEKS OF BASIC COMBAT TRAINING



FT JACKSON 1984, N = 310 (124 M, 186 F)

FIGURE 2. RISK OF 1ST ILLNESSES BY WEEK FOR MALE AND FEMALE ARMY TRAINEES DURING 8 WEEKS OF BASIC COMBAT TRAINING



FT JACKSON 1984, N = 310 (124 M, 186 F)

APPENDIX 1

COMPARATIVE DESCRIPTIVE CHARACTERISTICS OF GRADUATING AND DISCHARGED MALE AND FEMALE ARMY BASIC TRAINEES

MEANS AND STANDARD DEVIATIONS OF DESCRIPTIVE CHARACTERISTICS FOR FEMALES

VARIABLE	GRAD mean sd	DISCHARGE mean sd	P
TOT CAL	2915.82	2210.36	*.060
Kcal	2884.64	1897.68	
YRS EX	3.97	3.98	.998
yrs	4.57	3.81	
SELF-ASSESSMENT	2.62	2.57	.744
(Not active - very active) (4 point scale)	.90	.89	
AGE	21.17	21.33	.770
yrs		3.14	
HEIGHT	161.91	163.50	.142
cm	6.58	6.61	
WEIGHT	58.70	63.02	+.002
kg	5.76	8.49	
BMI	22.41	23.63	+.029
	1.98	3.63	
% BODY FAT	25.16	26.47	*.073
	4.20	4.49	
NEW HEIGHT	163.31	164.90	.142
cm	6.58	6.61	
ATHLETIC STATUS	2.12	1.94	.111
(Varsity - non athlete, 4 point scale)	.92	.92	

* Marginally significant, P <= .10
+ significant, P < .05

FT JACKSON 1984

MEANS AND STANDARD DEVIATIONS OF DESCRIPTIVE CHARACTERISTICS FOR MALES

VARIABLE	GRAD mean sd	DISCHARGE mean sd	P
TOT CAL	4712.03	3374.11	*.086
Kcal	4219.03	3662.74	
YRS EX	4.86	3.56	*.107
yrs	3.98	3.64	
SELF-ASSESSMENT	2.82	2.43	+.031
(Not active - very active) (4 point scale)	.86	.95	
AGE	20.17	21.2	.162
yrs	2.73	4.04	*.087
HEIGHT	173.76	174.46	.625
cm	6.62	7.54	
WEIGHT	73.57	75.54	.400
kg	(10.90)	(12.54)	
BMI	24.32	24.78	.490
	(3.09)	(3.57)	
% BODY FAT	16.95	16.79	.885
	(4.87)	(5.79)	
NEW HEIGHT	175.16	175.86	.625
cm	(6.62)	(7.54)	
ATHLETIC STATUS	2.46	2.29	.266
(Varsity - non athlete, 4 point scale)	(.75)	(.83)	

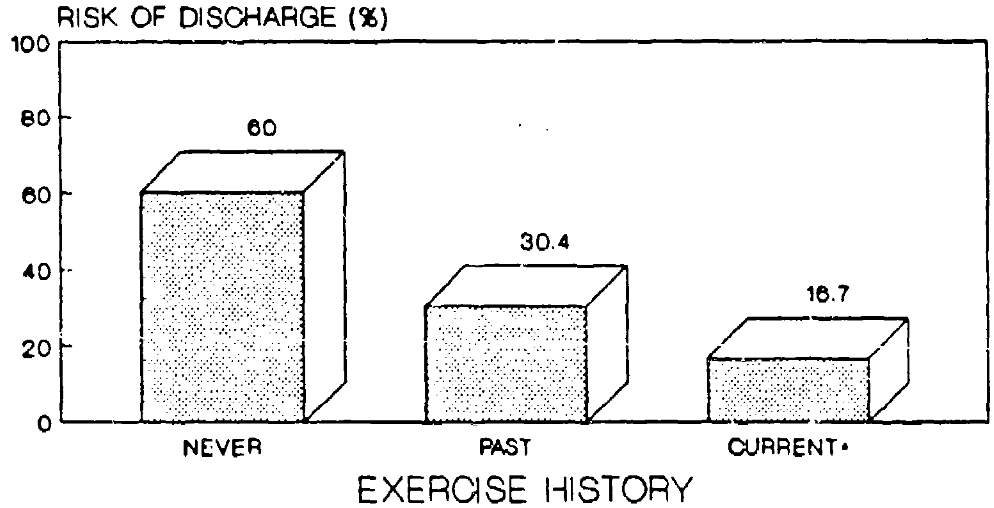
* Marginally significant, P <= .10
+ significant, P < .05

FT JACKSON 1984

APPENDIX 2

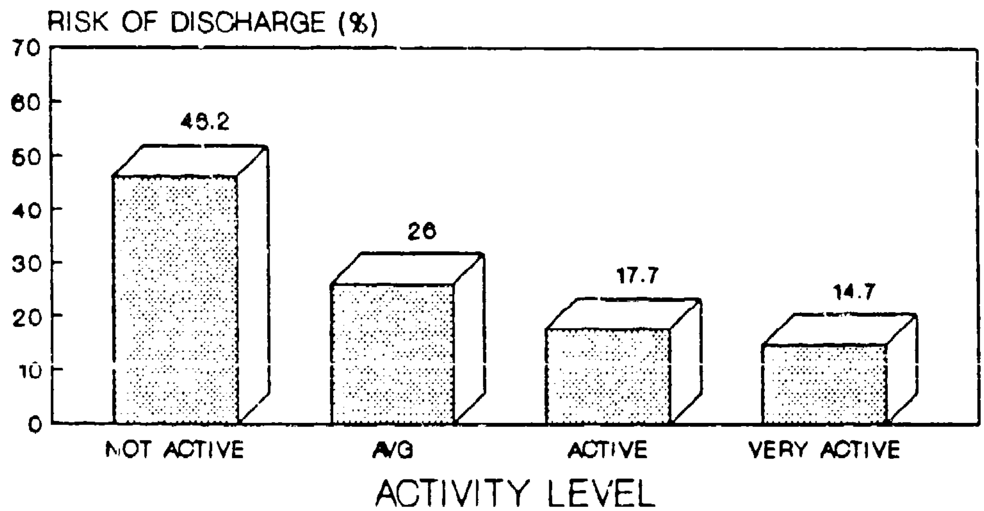
GRAPHIC DEPICTION OF THE ASSOCIATION BETWEEN PHYSICAL FITNESS AND RISK OF DISCHARGE FOR MALE AND FEMALE ARMY BASIC TRAINEES

RISK OF DISCHARGE FROM ARMY BT VS EXERCISE HISTORY PRIOR TO ENLISTMENT IN MALE TRAINEES



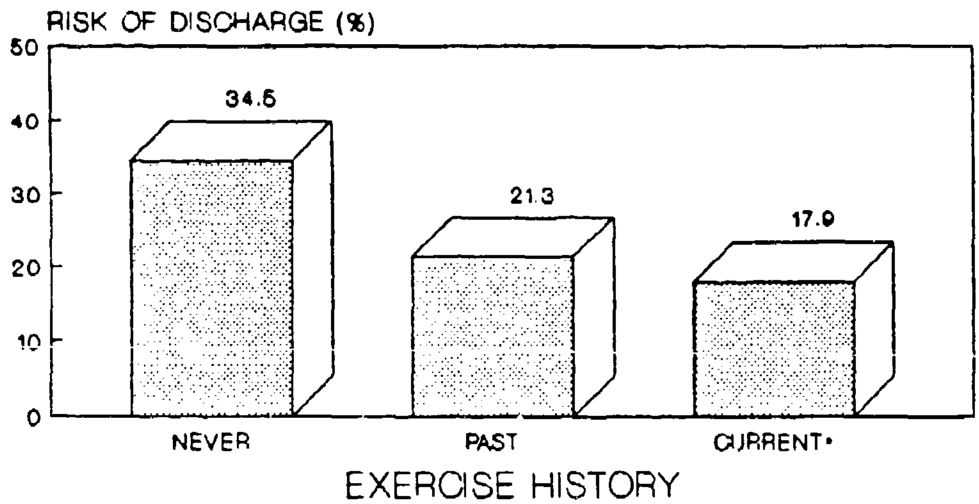
* 6 mos PRIOR TO ENLISTMENT
FT JACKSON,1984, N = 159
(N = 5, P = 46, C = 108),CHI SQ, P =.02

RISK OF DISCHARGE FROM ARMY BT VS RECENT ACTIVITY LEVEL IN MALE TRAINEES



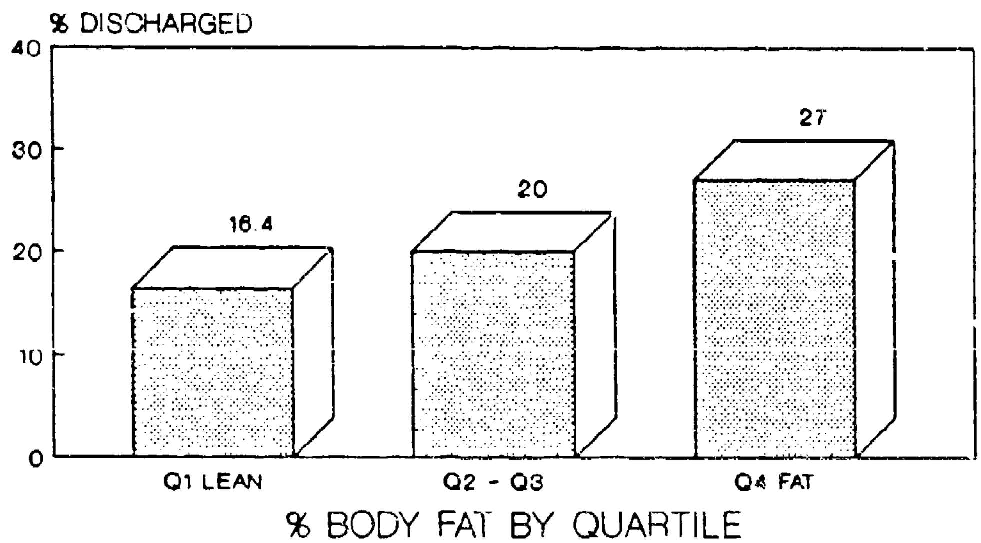
FT JACKSON, 1984, N = 159
(NA = 13, AVG = 50, A = 62, VA = 34)
CHI SQ, P = 0.08

RISK OF DISCHARGE FROM ARMY BT VS EXERCISE HISTORY PRIOR TO ENLISTMENT IN FEMALE TRAINEES



* 6 mos PRIOR TO ENLISTMENT
FT JACKSON, 1984, N = 235
(N = 29, P = 61, C = 145) CHI SQ, P = .13

RISK OF DISCHARGE vs % BODY FAT IN FEMALE ARMY TRAINEES FT JACKSON 1984



N = 186

APPENDIX 3

DESCRIPTIVE CHARACTERISTICS OF MALE AND FEMALE ARMY TRAINEES WITH MEDIAN, RANGE AND CUTPOINTS FOR THE 1ST AND 3RD QUARTILES OF KEY VARIABLES

DESCRIPTIVE CHARACTERISTICS OF FEMALE ARMY TRAINEES

ITEM	MEDIAN	RANGE	CUTPOINTS Q1*	Q3+
AGE yrs	20.0	17-29	19.0	22.0
HEIGHT cm	163.4	150-178	158	167
WEIGHT kg	59.0	43-73	55.0	62.8
%BF	25.1	14-37	22.4	28.4
BMI	22.5	18-27	21.1	23.6
1 MILE mins	9.8	6.0-16.3	9.0	10.4
SIT-UPS1 reps/2min	30.0	6-66	30.0	46.0
PUSH-UPS1 reps/2min	11.0	1-30	5.0	17.0
2 MILE mins	18.1	13-22	17.0	19.3
SIT-UPS2 reps/2min	51.0	19-72	43.0	57.0
PUSH-UPS2 reps/2min	17.0	5-40	13.0	21.8
TOTAL CAL Kcal	1860	20-16K	1050	3655
YRS EX yrs	3.0	0-27	1.6	6.4

* Quartile number 1
\+ Quartile number 3

FT JACKSON 1984

DESCRIPTIVE CHARACTERISTICS OF MALE ARMY TRAINEES

ITEM	MEDIAN	RANGE	CUTPOINTS Q1*	Q3+
AGE (yrs)	19	17-31	18.0	21.0
HEIGHT (cm)	174.4	158-194	170	180
WEIGHT (kg)	73.0	53-103	66.0	80.8
%BF	16.6	7-29	13.1	20.6
BMI	23.7	19-31	22.1	26.5
1 MILE (mins)	7.0	5.9-11.5	6.4	7.7
SIT-UPS1 (reps/2min)	52.0	16-99	46.8	64.0
PUSH-UPS1 (reps/2min)	31.0	4-53	26.5	36.0
2 MILE (mins)	14.2	12-19	13.3	15.5
SIT-UPS2 (reps/2min)	54.0	26-78	48.0	59.5
PUSH-UPS2 (reps/2min)	35.0	10-61	30.0	42.5
TOTAL CAL (Kcal)	3600	30-18K	1540	6285
YRS EX (yrs)	3.7	0-20	2	7

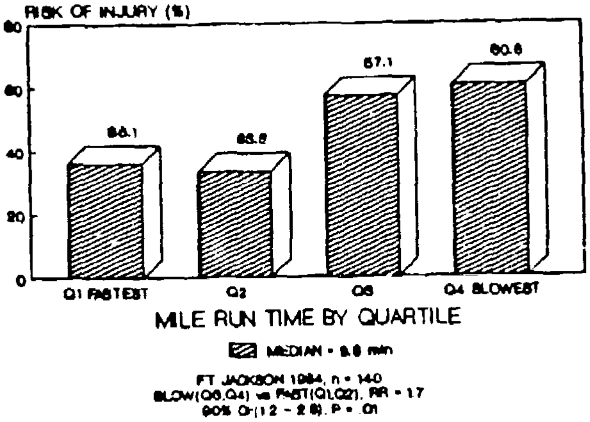
* Quartile number 1
\+ Quartile number 3

FT JACKSON 1984

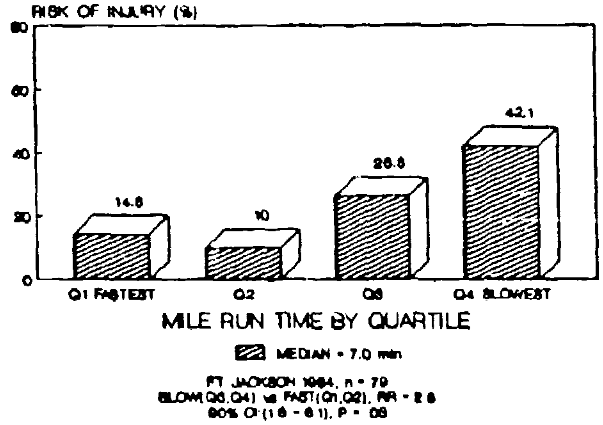
APPENDIX 4

GRAPHIC DEPICTION OF THE ASSOCIATION OF PHYSICAL FITNESS, ACTIVITY AND ANTHROPOMETRIC VARIABLES WITH RISK OF INJURY AMONG MALE AND FEMALE ARMY BASIC TRAINEES

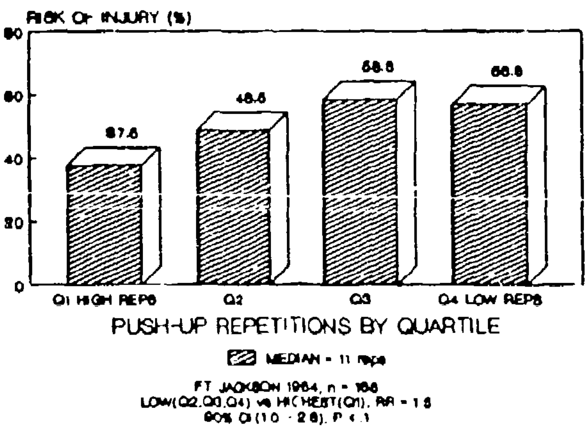
ASSOCIATION OF INJURY WITH MILE RUN TIME IN FEMALE ARMY TRAINEES



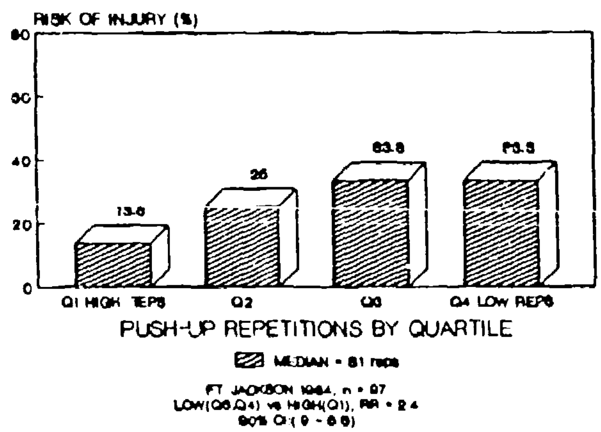
ASSOCIATION OF INJURY WITH MILE RUN TIME IN MALE ARMY TRAINEES



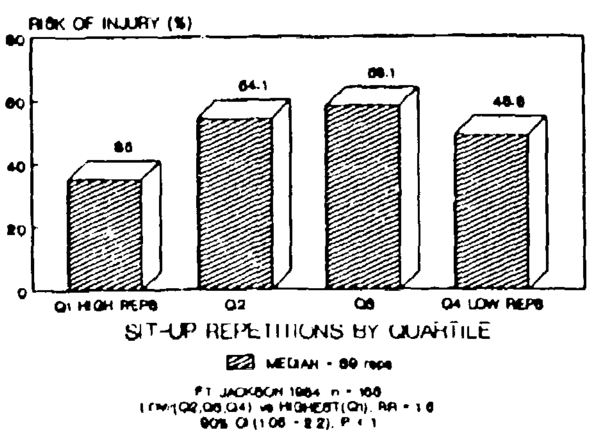
ASSOCIATION OF INJURY WITH PUSH-UPS IN FEMALE ARMY TRAINEES



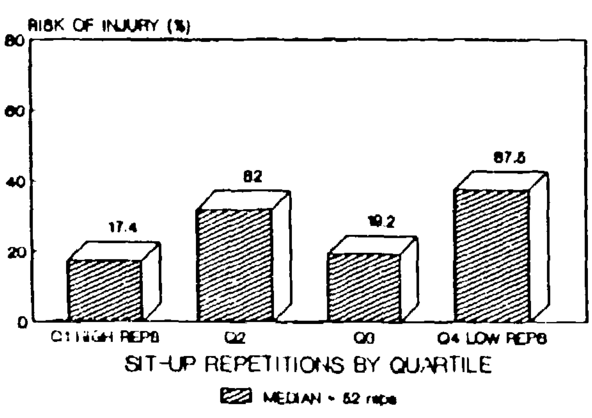
ASSOCIATION OF INJURY WITH PUSH-UPS IN MALE ARMY TRAINEES



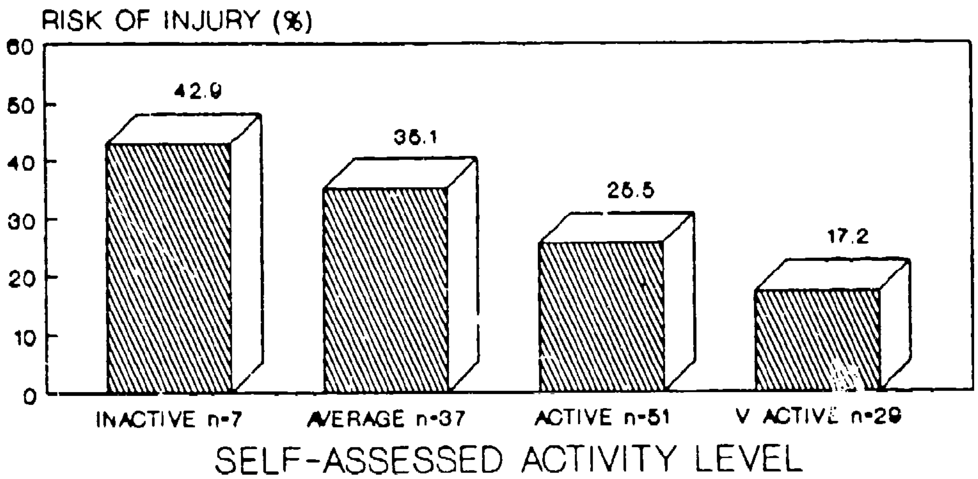
ASSOCIATION OF INJURY WITH SIT-UPS IN FEMALE ARMY TRAINEES



ASSOCIATION OF INJURY WITH SIT-UPS IN MALE ARMY TRAINEES

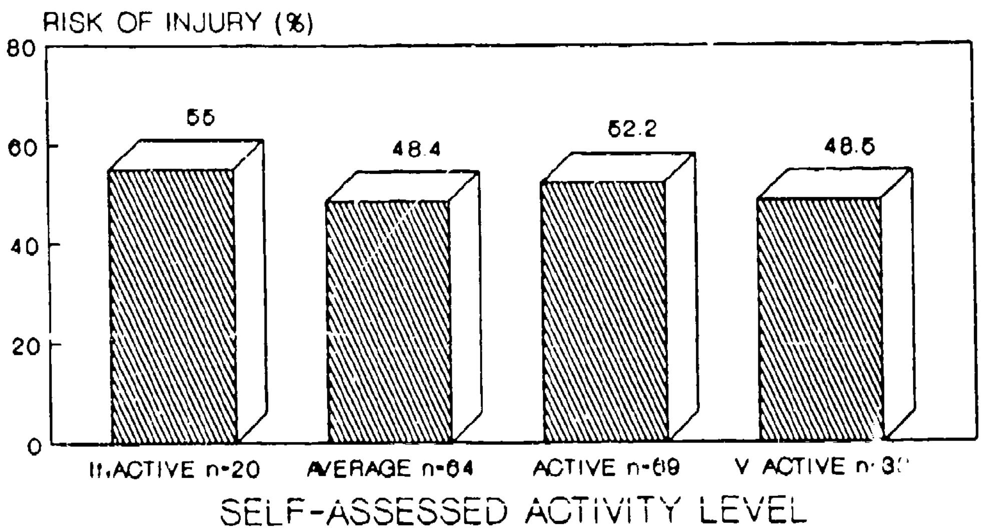


ASSOCIATION OF INJURY WITH SELF-ASSESSED ACTIVITY LEVEL IN MALE ARMY TRAINEES



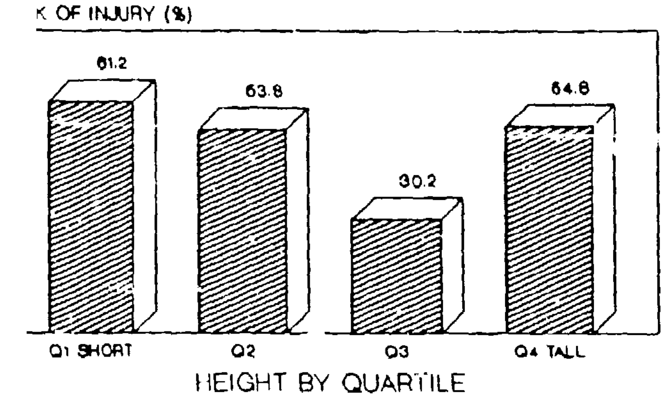
FT JACKSON 1984, n = 124
(NA,AVG) vs (ACT,VA), RR = 1.6
90% CI:(1.0 - 2.6), P < .1

ASSOCIATION OF INJURY WITH SELF-ASSESSED ACTIVITY LEVEL IN FEMALE ARMY TRAINEES



FT JACKSON 1984, n = 186

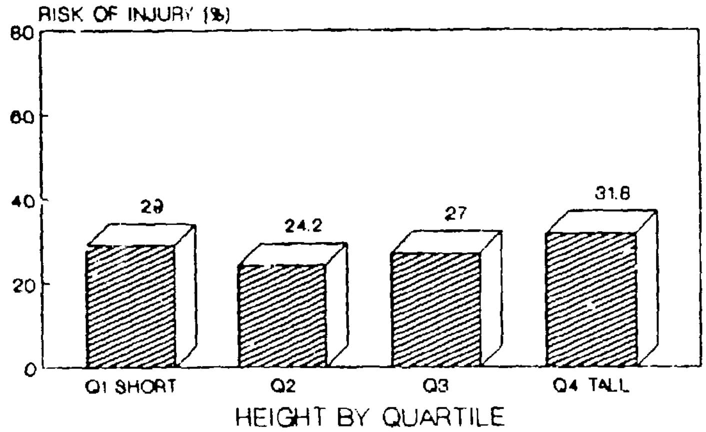
ASSOCIATION OF INJURY WITH HEIGHT IN FEMALE ARMY TRAINEES



MEDIAN = 163.4 cm

FT JACKSON 1984, n = 186
SHORT(Q1) vs AVG(Q3), RR = 2.0
90% CI (1.3 - 3.1), P = .006

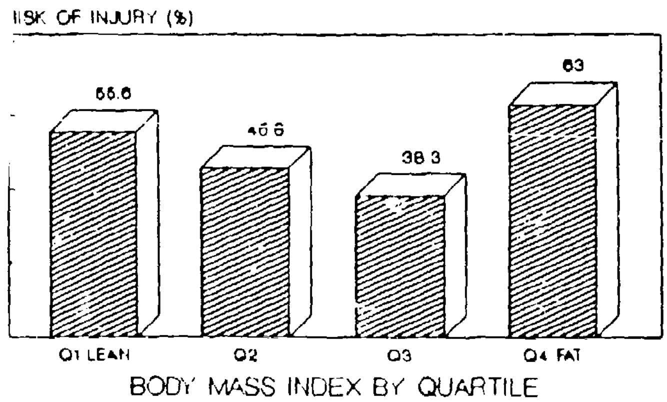
ASSOCIATION OF INJURY WITH HEIGHT IN MALE ARMY TRAINEES



MEDIAN = 175.4 cm

FT JACKSON 1984, n = 123

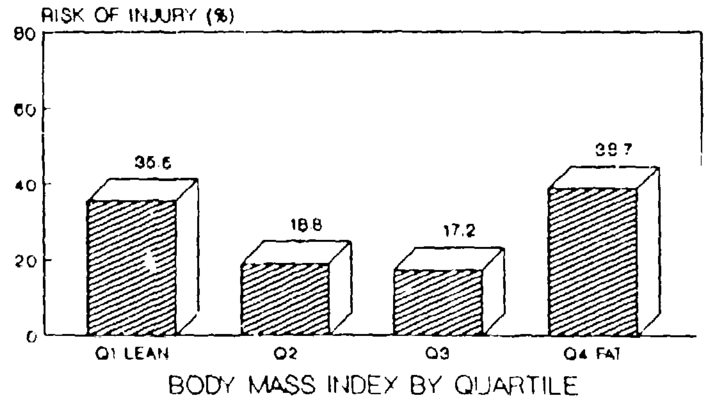
ASSOCIATION OF INJURY WITH BMI* IN FEMALE ARMY TRAINEES



MEDIAN = 22.5

FT JACKSON 1984, n = 186, *BMI=(WT/HT*HT)
FAT(Q4) vs AVG(Q2,Q3), RR = 1.5
90% CI (1.1 - 1.9), P < .1

ASSOCIATION OF INJURY WITH BMI* IN MALE ARMY TRAINEES



MEDIAN = 23.7

FT JACKSON 1984, n = 124, *BMI (WT/HT*HT)
FAT(Q4) vs AVG(Q2,Q3), RR = 2.2
90% CI (1.2 - 3.9), P = .03

APPENDIX 5

COMPARISON OF PHYSICAL CHARACTERISTICS AND FITNESS OF MALE AND FEMALE ARMY TRAINEES FROM 3 STUDIES

COMPARISON OF PHYSICAL CHARACTERISTICS AND FITNESS OF MALE AND FEMALE ARMY TRAINEES FROM 3 STUDIES

BENSEL 1983

VARIABLE	FEMALES	MALES	RATIO F/M
1.5 MILE RUN (post training)			
WITH SL BOOT *	N = 1346 11.02min	N = 425 13.51min	1.23
WITH HW BOOT +	N = 728 11.03min	N = 342 13.40min	1.21

* Standard leather boot.
\+ Hot weather (tropical) boot.

PATTON 1980

VARIABLE	FEMALES N = 57	MALES N = 67	RATIO F/M
AGE (yrs)	19.7	19.6	1.00
HT (cm)	159.9	172.8	.92
WT (kg)	66.9	69.6	.81
BODY FAT (%)	28.2	16.3	1.73
VO_2 MAX (ml/kg•min)	36.9	50.7	.72
PRE-MILE RUN (min) (with boots)	11.97	8.20	1.34
POST-MILE RUN (min) (with boots)	9.40	7.38	1.27

VOGEL 1986

VARIABLE	FEMALES N =212	MALES N=210	RATIO F/M
AGE (yrs)	19.7	19.7	1.00
HT (cm)	162.0	174.7	.93
WT (kg)	58.6	70.5	.83
BODY FAT (%)	28.4	15.6	1.82
VO_2 MAX (ml/kg•min)	37.5	51.1	.73

APPENDIX 6

BMDP STATISTICAL PACKAGE OUTPUT FOR LOGISTIC REGRESSION MODELS OF THE RELATIONSHIP BETWEEN INJURY AND DEMOGRAPHIC, ANTHROPOMETRIC AND PHYSICAL FITNESS FACTORS

STEP NUMBER 0

	LOG LIKELIHOOD =	-117.895		
GOODNESS OF FIT CHI-SQ	(2*O*LN(O/E)) =	233.017	D.F. = 171	P-VALUE= 0.001
GOODNESS OF FIT CHI-SQ	(C.C. BROWN) =	0.000	D.F. = 0	P-VALUE= 1.000

TERM	COEFFICIENT	STANDARD ERROR	COEFF/S.E.	EXP(COEFFICIENT)
CONSTANT	-0.47184	0.1545	-3.053	0.6239

STATISTICS TO ENTER OR REMOVE TERMS

TERM	APPROX. F TO ENTER	D.F.	D.F.	APPROX. F TO REMOVE	D.F.	D.F.	P-VALUE
SEX	11.03	1	175				0.0011
AGE	0.82	2	174				0.4403
RACE	0.22	2	174				0.8001
AT-STAT	0.39	3	173				0.7594
ASSESS	0.10	3	173				0.9607
HT	4.44	2	174				0.0133
WT	1.64	2	174				0.1979
MILTM	15.01	1	175				0.0002
SITUP	7.94	2	174				0.0005
PUSH	6.06	2	174				0.0029
NEWPERBF	5.61	2	174				0.0044
CONSTANT				9.27	1	175	0.0027
CONSTANT				IS IN			MAY NOT BE REMOVED.

```
****************************************
* TIME USED IS      44.40 SECONDS *
****************************************
```

BMDP: Stepwise logistic regression model of injury versus sex, age, race, athletic status, self-assessed phys activity, height, weight, miletime, situps, push-ups, percent body fat.

PAGE 34 BMDPLR LOGISTIC REG. WITH VARIABLES [illegible] INTO THE EQUATION

STEP NUMBER 1 MILTM IS ENTERED

	LOG LIKELIHOOD =	-111.006		
IMPROVEMENT CHI-SQUARE	(2*(LN(MLR)) =	13.779	D.F. = 1	P-VALUE= 0.000
GOODNESS OF FIT CHI-SQ	(2*O*LN(O/E)) =	219.239	D.F. = 170	P-VALUE= 0.007
GOODNESS OF FIT CHI-SQ	(C.C. BROWN) =	0.000	D.F. = 0	P-VALUE= 1.000

TERM	COEFFICIENT	STANDARD ERROR	COEFF/S.E.	EXP(COEFFICIENT)
MILTM	1.2559	0.3439	3.652	3.511
CONSTANT	-0.86642	0.1959	-4.422	0.4205

CORRELATION MATRIX OF COEFFICIENTS

	MILTM	CONSTANT
MILTM	1.000	
CONSTANT	-0.570	1.000

STATISTICS TO ENTER OR REMOVE TERMS

TERM	APPROX. F TO ENTER	D.F.	D.F.	APPROX. F TO REMOVE	D.F.	D.F.	P-VALUE
SEX	2.52	1	174				0.1145
AGE	0.45	2	173				0.6413
RACE	0.11	2	173				0.8918
ATHSTAT	0.63	3	172				0.5975
ASSESS	0.04	3	172				0.9897
HT	1.22	2	173				0.2967
WT	0.21	2	173				0.8132
MILTM				13.19	1	174	0.0004
SITUP	3.97	2	173				0.0206
PUSH	2.90	2	173				0.0580
NEWPERBF	1.94	2	173				0.1472
CONSTANT				19.33	1	174	0.0000
CONSTANT				IS IN		MAY NOT BE REMOVED	

****
* TIME USED IS 49.13 SECONDS *
****

PAGE 35 BMDPLR LOGISTIC REG. WITH VARIABLES . . INTO THE EQUATION

STEP NUMBER 2 SITUP IS ENTERED

	LOG LIKELIHOOD =	-107.050			
IMPROVEMENT CHI-SQUARE	(2*(LN(MLR)) =	7.912	D.F. = 2	P-VALUE= 0.019
GOODNESS OF FIT CHI-SQ	(2*O*LN(O/E)) =	211.327	D.F. = 168	P-VALUE= 0.013
GOODNESS OF FIT CHI-SQ	(HOSMER-LEMESHOW)=	0.809	D.F. = 4	P-VALUE= 0.937
GOODNESS OF FIT CHI-SQ	(C.C.BROWN) =	0.809	D.F. = 2	P-VALUE= 0.667

TERM		COEFFICIENT	STANDARD ERROR	COEFF/S.E.	EXP(COEFFICIENT)
MILTM		0.93701	0.3733	2.510	2.552
SITUP	(1)	-0.71771E-01	0.3992	-0.1798	0.9307
	(2)	-1.0786	0.4445	-2.427	0.3401
CONSTANT		-0.39740	0.3424	-1.161	0.6721

CORRELATION MATRIX OF COEFFICIENTS

	MILTM	SITUP(1)	SITUP(2)	CONSTANT
MILTM	1.000			
SITUP(1)	0.244	1.000		
SITUP(2)	0.336	0.516	1.000	
CONSTANT	-0.585	-0.707	-0.703	1.000

STATISTICS TO ENTER OR REMOVE TERMS

TERM	APPROX F TO ENTER	D.F.	D.F.	APPROX. F TO REMOVE	D.F.	D.F.	P-VALUE
SEX	0.62	1	172				0.4315
AGE	0.38	2	171				0.6819
RACE	0.17	2	171				0.8451
ATHSTAT	1.25	3	170				0.2924
ASSESS	0.10	3	170				0.9585
HT	0.46	2	171				0.6295
WT	0.04	2	171				0.9586
MILTM				6.15	1	172	0.0141
SITUP				3.64	2	171	0.0283
PUSH	1.44	2	171				0.2388
NEWPERSF	0.77	2	171				0.4659
CONSTANT				1.32	1	172	0.2530
CONSTANT				IS IN			MAY NOT BE REMOVED

NO TERM PASSES THE REMOVE AND ENTER LIMITS (0.1500 0.1000)

****
* TIME USED IS 53.98 SECONDS *

PAGE 18 BMDPLR LOGISTIC REG. WITH VARIABLES . INTO THE EQUATION

STEP NUMBER 0

	LOG LIKELIHOOD	=	-165.139			
GOODNESS OF FIT CHI-SQ	(2*O*LN(O/E))	=	324.733	D.F. = 237	P-VALUE =	0.000
GOODNESS OF FIT CHI-SQ	(C.C. BROWN)	=	0.000	D.F. = 0	P-VALUE =	1.000

TERM	COEFFICIENT	STANDARD ERROR	COEFF/S.E.	EXP(COEFFICIENT)
CONSTANT	-0.36464	0.1302	-2.801	0.6944

STATISTICS TO ENTER OR REMOVE TERMS

TERM	APPROX F TO ENTER	D.F.	D.F.	APPROX F TO REMOVE	D.F.	D.F.	P-VALUE
SEX	11.47	1	242				0.0008
AGE	1.08	2	241				0.3423
RACE	0.16	2	241				0.8496
TOTCAL	1.10	2	241				0.3346
YREXER	0.13	2	241				0.8777
ATHSTAT	1.79	3	240				0.1501
ASSESS	0.89	3	240				0.4492
HT	4.91	2	241				0.0081
WT	2.48	2	241				0.0859
AVGPERBF	4.50	2	241				0.0121
CONSTANT				7.81	1	242	0.0055
CONSTANT				IS IN			MAY NOT BE REMOVED

```
************************************
* TIME USED IS       45.20 SECONDS *
************************************
```

BMOP: **Stepwise logistic regression model for injury versus sex, age, race, total cal per wk of exercise, yrs of exercise, athletic status, self-assessed physical activity, height, weight, percent body fat.**

PAGE 19 BMDPLR LOGISTIC REG. WITH VARIABLES . . INTO THE EQUATION

STEP NUMBER 1 SEX IS ENTERED

	LOG LIKELIHOOD =	-159.520			
IMPROVEMENT CHI-SQUARE	(2*(LN(MLR)) =	11.237	D.F. = 1	P-VALUE= 0.001
GOODNESS OF FIT CHI-SQ	(2*O*LN(O/E)) =	313.496	D.F. = 236	P-VALUE= 0.001
GOODNESS OF FIT CHI-SQ	(C.C. BROWN) =	0.000	D.F. = 0	P-VALUE= 1.000

TERM	COEFFICIENT	STANDARD ERROR	COEFF/S.E.	EXP(COEFFICIENT)
SEX	0.90287	0.2746	3.288	2.467
CONSTANT	-0.90287	0.2164	-4.171	0.4054

CORRELATION MATRIX OF COEFFICIENTS

	SEX	CONSTANT
SEX	1.000	
CONSTANT	-0.788	1.000

STATISTICS TO ENTER OR REMOVE TERMS

TERM	APPROX F TO ENTER	D.F.	D.F.	APPROX. F TO REMOVE	D.F.	D.F.	P-VALUE
SEX				10.72	1	241	0.0012
AGE	0.39	2	240				0.6762
RACE	0.20	2	240				0.8183
MARITAL	0.41	2	240				0.6654
PREFER	0.28	2	240				0.7575
ATT-STAT	1.43	3	239				0.2332
ASSESS	0.79	3	239				0.5018
HT	1.03	2	240				0.3598
WT	0.32	2	240				0.7293
GENPEREF	0.43	2	240				0.6521
CONSTANT				17.26	1	241	0.0000
CONSTANT				IS IN			MAY NOT BE REMOVED

NO TERM PASSES THE REMOVE AND ENTER LIMITS (0.1500 0.1000).

****
* TIME USED IS 51.45 SECONDS *
****

PAGE 20 BMDPLR LOGISTIC REG. WITH VARIABLES . . INTO THE EQUATION

SUMMARY OF STEPWISE RESULTS

STEP NO.	TERM ENTERED	TERM REMOVED	DF	LOG LIKELIHOOD	IMPROVEMENT CHI-SQUARE	IMPROVEMENT P-VAL	GOODNESS OF FIT CHI-SQUARE	GOODNESS OF FIT P-VAL
0				-165.139			324.723	0.000
1	SEX		1	-159.520	11.237	0.001	313.496	0.001

NUMBER OF INTEGER WORDS OF STORAGE USED IN PRECEDING PROBLEM 12552
CPU TIME USED 54.450 SECONDS

APPENDIX 7

PHYSICAL ACTIVITY AND FITNESS QUESTIONNAIRE

Name ______________ Date ______________ Age ______________ Sex ______________
Year, Month, Day

Unit ______________ SSN ______________

PHYSICAL ACTIVITY QUESTIONNAIRE

1. We are interested in your present "normal" level of physical activity. If you have done any of the activities listed below regularly in the last 6 months, circle the activity and write in the number of days per week you did the activity, and how many minutes on the average you did it on those days. Also, fill in the distance covered (where applicable) and how many years you have done this activity routinely.

	days/week	mins/day	distance/day	no. of yrs involved
walks or hikes	____	____	____ miles	____
bicycle rides	____	____	____ miles	____
swimming	____	____	____ yards	____
running/jogging	____	____	____ miles	____
calisthenics	____	____		____
weight lifting	____	____		____
karate, judo, etc.	____	____		____
tennis, squash, raquetball, etc.	____	____		____
baseball	____	____		____
basketball	____	____		____
football	____	____		____
soccer	____	____		____
dance	____	____		____
	____	____		____

2. If there are activities listed above which you have not done regularly in the last 6 months, but have done regularly at other times, please list these activities; how many yrs you did the activity; and what the last year you did it was.

Activity	How many yrs	Last year of involvement (1981, etc)
____________	____________	____________________
____________	____________	____________________

3. What type of recreational activities do you like best? (For instance fishing, baseball, cooking, pool, card games, etc.)

1. ____________________
2. ____________________
3. ____________________

4. How hard do you usually exercise? Very lightly — Average — Moderately hard — Very hard (Circle one)

5. Did you take Physical Education classes in school? 1. Never — 1 or 2 each week — 3 or more each week

If yes, when was the last time: This year — 1 year ago — 2 or more years ago (Circle one)

6. Did you take part in school or college sports? Yes — No

If yes, how many years? 1-2 yr — 3-4 yr — 5-6 yr — 7-8 yr

If yes, at what level: Unorganized with friends — Organized in school (intramural) competition — Varsity competition with other schools or colleges (Circle one)

List which sports ____

7. What type of Sports do you prefer? (for instance baseball, running, tennis, etc.)	1. ______ 2. ______ 3. ______			
8. How does your physical fitness compare to others like you? (same age, sex, etc.)	Poor	Average	Good	Excellent
		(Circle one)		
9. Is exercise important to your health?		Yes	No	
		(Circle one)		
10. How do you describe your life?	Not very active	Average	Active	Very Active
		(Circle one)		
11. Are your friends involved in sports?	Very few of them	Some of them	Most of them	All of them
		(Circle one)		

APPENDIX 8

COMPARISON OF INITIAL ANTHROPOMETRIC AND FITNESS MEASUREMENTS OF WOMEN IN THE TWO SEPARATE COMPANIES INVOLVED IN THIS STUDY

- - - - - - - - - - - T - T E S T - - - - - - - - - - -

GROUP 1 - COMP EQ 2
GROUP 2 - COMP EQ 3

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
TOTCAL	GROUP 1	89	2784.5730	2767.751	292.321	1.25	0.329	-0.83	156	0.410	-0.81	137.71	0.417
	GROUP 2	69	3169.0725	3079.298	370.704								
YREXER	GROUP 1	87	3.9011	4.342	0.465	1.27	0.290	-0.39	160	0.700	-0.38	149.45	0.702
	GROUP 2	75	4.1813	4.886	0.564								
ASSESS	GROUP 1	102	2.6275	0.933	0.092	1.14	0.536	-0.02	181	0.987	-0.02	176.17	0.987
	GROUP 2	81	2.6296	0.872	0.097								
ATHSTAT	GROUP 1	102	2.2451	0.969	0.096	1.27	0.268	1.07	181	0.288	1.08	178.72	0.281
	GROUP 2	81	2.0988	0.860	0.096								
MILTM	GROUP 1	83	9.6559	1.301	0.143	1.09	0.718	-0.76	135	0.446	-0.76	109.88	0.450
	GROUP 2	54	9.8328	1.358	0.185								
PUSH	GROUP 1	73	8.3425	9.924	1.161	1.66	0.043	-5.81	133	0.000	-5.93	131.98	0.000
	GROUP 2	62	17.3387	7.699	0.978								
SITUP	GROUP 1	96	36.8229	11.878	1.212	1.01	0.966	-1.18	158	0.239	-1.18	134.87	0.239
	GROUP 2	64	39.0938	11.916	1.490								

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Director
Army Physical Fitness Research Institute
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US Army War College
Carlisle Barracks, PA 17013

1 Copy to:

Director
Soldier Physical Fitness School
ATTN: ATSG-PF
US Army Soldier Support Institute
Fort Benjamin Harrison, IN 46216

1 Copy to:

Dr. James Hodgdon
Environmental Physiology Department
US Naval Health Research Center
P.O. Box 85122
San Diego, CA 92138

1 Copy to:

Dr. M. F. Haisman
Head, Applied Physiology
Army Personnel Research Establishment
c/o RAE
Farnborough
Hants, GU14 6TD
United Kingdom

2 Copy to:

MAJ Robert H. Stretch, Ph.D.
DCIEM
1133 Sheppard Ave W.
P. O. Box 2000
Downsview, Ontario CANADA M3M 3B9

1 Copy to:

Flight Lieutenandt S. J. Legg
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